AN INTRODUCTION TO THE
PRACTICE OF PREVENTIVE MEDICINE

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WITH APPENDIX ARTICLES BY VARIOUS CONTRIBUTORS

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TO

E. L. F.

PREFACE

There has been during recent years a very impressive change in the attitude of the community as a whole to the problems of preventive medicine. Countries, provinces, cities, and towns have, in many instances, given concrete illustrations of their abiding faith in the old adage that prevention is better than cure, by appropriating large sums of money for the purpose of public health.

The banner Province of the Dominion of Canada, Ontario, now spends about 2 per cent of its total revenue in this way. The capital city of that Province, Toronto, does likewise. The motto of the New York State Department of Health is: "Public Health is purchasable; within natural limitations any community can determine its own death rate." This motto is being literally applied in these, as in many other places. It is probable that in a short time no province, state or municipality will be found wanting in this important matter.

The time has arrived, however, when in a much larger measure, physicians in general practice must become integral factors in the public health program. Community cleanliness, control of communicable diseases, arrangements for the supervision of milk and water supplies, with adequate provision for a public health nursing service is paid for by taxation. But there is need of the cooperation of the family physician in addition to ensure the smooth running of the public health machine. Full-time public health workers, administrators, physicians, sanitary engineers, public health nurses and others, provide the personnel for the execution of that part of the work for which the organized political unit pays. This additional service should supply the necessary care and supervision of the general health of individuals in the community. For this task no one is so well qualified as the physician in general practice. He can not only take a place, perhaps on a part-time basis, in the organized and official public health work, but what is more important he can and will, become the supervisor of public health of the individual family.

To outline some of the work of the physician who is to function on the preventive as well as the curative side of medicine is the purpose of this book. It may be found useful by medical practitioners, students of medicine or public health nurses.

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CHAPTER I

AIMS AND PROBLEMS OF PREVENTIVE MEDICINE

The aim of the physician who is engaged in the practice of preventive, as well as of curative, medicine is so to advise and deal with patients entrusted to his charge that they will, from their earliest years, enjoy the benefits of vigorous bodily and mental health. Many books have been written dealing with the subject of personal hygiene, and health hints in abundance are purveyed for the edification and in the interest of those who will profit by the excellent advice so offered. It is found, however, in everyday life that unless precept is followed or accompanied by practice, too often, alas, no permanent advantages accrue.

It would seem, then, that our methods should be carefully scrutinized to ascertain in what way they might be modified to more certainly attain the end in view. The first observation of significance is this. Even in highly organized and advanced communities, the majority of the people are impressed with the necessity of obtaining medical or hygienic attention only, when they have been actually stricken by disease. The statement that "he was so sick he had to have the doctor," is still heard, and still accepted as the proper method of procedure. When the time arrives when every one in the community will feel that an actual stigma attaches to one who has a preventable physical or mental disability, then the duty of the physician will be clearly defined. He will be engaged to keep his patient well by routine examination, by supervision and advice. Then the day of the practitioner of preventive medicine will indeed have dawned!

It may seem possible that the golden age is so far away in the dim distant future that it is outside the realm of practical present-day work in preventive medicine. Nothing could be further from

the truth. The start has already been made, and in the last few years very much has been accomplished. The supervision of the expectant mother, the care of her infant when it arrives, the oversight of the health of her child during the period of its school life, all indicate recent satisfactory progress. Such health work, curiously enough, in some places is limited to those whose economic status is such that they can without difficulty pay for the service received, and on the other hand to those whose economic condition is such that they must take advantage of whatever is offered for those of limited financial means.

Such a state of affairs is not entirely satisfactory. Two further steps are necessary. First, the state should provide a service for those to whom the cost of complete health supervision is prohibitive and such a service should be free to all, rich and poor alike, and no stigma of charity should be attached to its acceptance. This service should include provision for antenatal supervision, home visitation, and infant welfare centers to safeguard the health of infants and little children. Medical, nursing and dental supervision in schools and colleges, and finally, clinics for periodic medical examinations of adults. Thus, health supervision would be provided for all those who chose to take advantage thereof: from infancy to old age. The second important point should be: No compulsion! Let those who pay their taxes and help provide the service offered by the state, arrange for their own private supervision should they so desire. Free education is now provided at the public expense. Many there are, however, who pay school taxes but take no advantage thereof. They prefer to have their children educated in schools not provided at the expense of the state.

There may very well be a parallel system of health supervision: the one provided (probably jointly), by the federal and provincial governments and the municipality; the other provided by individuals for themselves at their own expense. These suggestions relate almost entirely to the necessities on the preventive side. Analogous service will likely have to be established in curative medicine. And, while, that is not primarily the concern of those promoting health and preventing disease, arrangements for preventive and curative medicine should be very closely linked up, and the development of plans

for the one should be made with the needs of the other fully in mind.

It may not be out of place to indicate that the evolution of such a plan as this does not necessitate the application of principles to which many are opposed, such as the nationalization of the medical profession, or the introduction of national health insurance.

The primary aim should be clearly recognized; it is to provide for all the people (omitting those to whom it is, as a matter of principle, objectionable) satisfactory provision in the way of a service which will have as its first aim the promotion of health and the prevention of disease. This is the concern of the practitioner of preventive medicine. With it may be linked, a system of hospitals, etc., for curative medicine. In it all, however, prevention should be the keynote.

Now, nationalization does not of itself ensure prevention. If every physician were nationalized tomorrow, it would not necessarily mean any reduction whatever in the number of preventable deaths or diminution in the volume of preventable sickness. Since the aim is prevention, it is well to be sure that what is proposed will accomplish what is desired. In a like manner insurance does not of itself secure prevention of preventable deaths or lessen avoidable sickness. It simply provides a money benefit which may be used wisely by the individual in *his efforts to regain, not to maintain his health;* or on the other hand like the English Maternity Benefit, in many cases it may be used injudiciously. Not nationalization or insurance, but the application of tried and proved methods of prevention are what is needed!

In such a plan there are, in a general way, three parties concerned. The general public, persons charged with administrative details, and physicians who would be largely responsible for the work. For the purpose of clearer definition, let us for a moment examine the place of the physician in such a scheme. He may be, if suitably trained and so minded, a full-time public health worker, either an administrator, laboratory worker or public health physician. Or, he may on the other hand, be a physician in general or special practice. Those occupied in general practice will comprise the large majority. Time need not be spent considering the status and case of the physician engaged exclusively in public health work. His place is established and his

relationships are clearly defined. It is the physician in general practice whose position must be indicated. It will not be necessary for the highly desirable relationship so frequently existing between physician and patient to be disturbed in the slightest degree by what has been proposed. It will, however, imply that the physician on his side shall be competent to act as *health supervisor* to the members of the family, and on the part of the family, a desire to be maintained in good health through consultation at regular intervals, and, by the application of advice received on such occasions. Those who now consult their own physicians when ill will continue to do so. In addition, they would consult him periodically, when well, for examination and advice as to how to maintain health. For others the clinics and health centers should be made available. For those in both groups the work should be initiated at birth and continued until death. For all, the work could be done by physicians in private practice, specialists and general practitioners.

Part of their work may be paid for by the state. Such work they would do at a public clinic or health center. The rest of their time would be occupied with the care of their own private patients. In this way no great, unwieldy and unmanageable body of bureaucrats would be created. The physician desiring a public career would find the way open to him. On the other hand, men desiring to engage in private practice could do so. There is nothing novel in this suggestion. It is in essence what is actually being done at the present time, in a limited fashion, in the city of Toronto. In cooperation with the Department of Health of the city, there are clinics and centers, the medical work of which is done by physicians who are also engaged in private practice. Examples of this are to be seen in the Associated Tuberculosis Clinics of Toronto; in the Venereal Disease Clinics, the Psychopathic Clinics, and also, in part of the "Well-Baby" Centers, and the Antenatal Clinics. This is as it should be: and soon no doubt, there will be clinics for periodical medical examinations. These clinics and centers are for those who wish to take advantage of the facilities offered. There is no discrimination between rich and poor. They are free alike to all. But, no one is compelled to attend; and any citizen is at liberty to have his own physician as his health supervisor should he so prefer. These centers, it is true, do give treatments as well as advice and education. But in all, the preventive aspect is empha-

sized, and health promotion, through early diagnosis and the application of appropriate measures, is the aim.

Even now with such provision much remains to be done. There is still a very large amount of preventable sickness and every year many preventable deaths are reported. Let us remember, however, that a start has been made, and with the further education of physicians, and the general public, much more will be accomplished in the next decade.

It is now necessary to consider the problem before us and to look first into the matter of causes of death. A study of these will reveal, as Winslow has pointed out, in a general way, two broad groups of causes of death. The first includes the important causes of death which are chiefly of external origin and theoretically, at least, preventable; and secondly those causes of death which are mostly of internal origin and not preventable in the present state of our knowledge.

Winslow has illustrated this classification by reference to the deaths in the registration area of the United States for the year 1909. In that year there were 732,538 deaths. Of this number 174,470 were due to a variety of minor causes difficult to classify. This still leaves 558,068 deaths, or 76 per cent of the total number, which were due to eleven main causes. These may be classified as shown in Table I.

TABLE I

IMPORTANT CAUSES OF DEATH WHICH ARE IN THE MAIN OF EXTERNAL ORIGIN AND THEREFORE PREVENTABLE

Typhoid fever	10,722
Diphtheria	10,358
Other epidemic diseases	28,908
Tuberculosis	81,720
Pneumonia and other respiratory diseases	90,868
Diarrhea of infants	44,648
Accidents	47,135
Total	314,359

IMPORTANT CAUSES OF DEATH WHICH ARE IN THE MAIN OF INTERNAL ORIGIN AND NOT AT PRESENT PREVENTABLE

Cancer and tumors	38,020
Nervous diseases	66,803
Circulatory diseases	90,456
Bright's disease	48,430
Total	243,709

TABLE II

PREVENTABLE DEATHS IN ALL REGISTRATION CITIES—1913

CAUSE OF DEATH	NUMBER OF DEATHS		PER CENT OF PREVENTABLE DEATHS
Infectious diseases		149,600	99.0
Tuberculosis—all forms		56,624	37.5
Lungs	48,733		
Meningitis	3,861		
Other forms	4,030		
Diarrhea and enteritis (under 2)		30,244	20.0
Bronchopneumonia		21,091	14.0
Common contagious diseases		19,058	12.6
Measles	4,517		
Scarlet fever	3,854		
Whooping cough	3,047		
Diphtheria and croup	7,640		
Typhoid fever		5,627	3.7
Syphilis—total		4,902	3.2
Syphilis	3,422		
Locomotor ataxia	1,020		
Softening of the brain	460		
Influenza		3,000	2.0
Puerperal fever		2,825	1.9
Gonococcus infection		191	0.1
Other infectious diseases		6,038	4.0
Erysipelas	1,599		
Dysentery	1,212		
Tetanus	876		
Cerebrospinal fever	834		
Malaria	644		
Infantile paralysis	392		
Cholera nostras	140		
"Other epidemic diseases"	124		
Rabies	67		
Smallpox	44		
Intestinal parasites	30		
Mycoces	24		
Hydatid tumor of liver	13		
Anthrax	12		
Ankylostomiasis	10		
Glanders	7		
Leprosy	4		
Typhus fever	3		
Relapsing fever	2		
Plague	1		
Nutritional diseases		1,097	0.7
Pellagra	702		
Rickets	335		
Scurvy	53		
Beriberi	7		
Poisoning by food		329	0.2
Industrial poisonings		124	0.1
Lead poisoning	120		
Other chronic occupational poisonings	4		
Total	151,150		100.00

In a somewhat similar manner Schneider has analyzed the preventable causes of death in the registration area of the United States for the year 1913. This is shown in Table II. These are practically the deaths resulting from disease caused by living micro-organisms and disease of nutrition, and deaths due to food and industrial poisoning.

Cancer is omitted from this list, though, as is pointed out, many

TABLE III

CAUSE OF DEATH	NO. OF DEATHS	RATE PER 100,000 POPULATION	PER CENT OF TOTAL
All causes*	1,096,436	1,287.7	100.0
Organic diseases of the heart	111,579	131.0	10.2
Tuberculosis (all forms)	106,985	125.6	9.8
Tuberculosis of the lungs†	94,772	111.3	8.6
Tuberculosis meningitis	5,175	6.1	.5
Other forms of tuberculosis	7,038	8.3	.6
Pneumonia (all forms)	105,213	123.6	9.6
Influenza	84,113	98.8	7.7
Acute nephritis and Bright's disease	75,005	88.1	6.8
Cancer and other malignant tumors	68,551	80.5	6.3
External causes (suicide excepted)	67,654	79.5	6.2
Cerebral hemorrhage and softening	66,918	78.6	6.1
Congenital debility and malformations	56,714	66.6	5.2
Diarrhea and enteritis (under 2)	37,635	44.2	3.4
Diabetes	12,683	14.9	1.2
Diphtheria and croup	12,551	14.7	1.1
Bronchitis	10,913	12.8	1.0
Appendicitis and typhilitis	10,029	11.8	.9
Suicide	9,732	11.4	.9
Puerperal affections, other than puerperal septicemia	9,538	11.2	.9
Respiratory diseases, other than pneumonia and bronchitis	8,865	10.4	.8
Hernia and intestinal obstruction	8,853	10.4	.8
Typhoid fever	7,860	9.2	.7
Cirrhosis of the liver	6,704	7.9	.6
Meningitis	5,508	6.5	.5
Puerperal septicemia	4,950	5.8	.5
Whooping cough	4,714	5.5	.4
Rheumatism	3,907	4.6	.4
Measles	3,296	3.9	.3
Malaria	3,275	3.8	.3
Scarlet fever	2,383	2.8	.2
Erysipelas	2,186	2.6	.2
Smallpox	358	.4	‡
All other defined causes	172,161	202.2	15.7
Unknown and ill-defined causes	15,603	18.3	1.4

*Exclusive of stillbirths
†Includes acute miliary tuberculosis
‡Less than one-tenth of 1 per cent.

deaths from cancer might be avoided by early operation. The list also omits the diseases of early infancy, and includes only broncho-pneumonia, and not other forms of pneumonia, and finally many deaths indirectly due to venereal diseases are omitted, though the evidence that they are directly and indirectly the cause of many deaths otherwise classified, is now becoming more manifest. Allowing for these omissions, this very conservative estimate indicates that 29 per cent of the deaths from all causes, were preventable.

Certainly much can be done, too, in the prevention of pneumonia and of the diseases of early infancy (prematurity, general debility, etc.), responsible for so many of the deaths during the first month of life.

The most recent figures for the registration area of the United States are those of 1919. The total deaths recorded in the registration area (which included 33 States, the District of Columbia, and 18 registration cities in nonregistration States, with a total estimate population of 85,147,822 or, 81.1 per cent of the estimated popula-

TABLE IV

	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
Organic heart Disease	89.7	96.2	100.0	96.4	105.5	105.7	108.1	102.4	102.1	116.0
Pneumonia	80.2	67.3	69.6	62.2	63.0	77.4	73.0	84.9	105.6	99.7
Tuberculosis	112.7	106.6	102.2	93.3	87.1	85.6	85.1	89.2	92.2	88.9
Cancer	61.5	71.5	70.8	63.5	68.9	67.4	69.6	71.6	72.6	79.3
Apoplexy	43.8	41.8	41.2	40.2	39.8	44.8	47.5	51.2	53.5	52.3
Diseases of the arteries	.....	31.1	34.4	39.0	44.2	41.7	39.7	44.8	43.4	46.8
Bright's disease	35.3	36.6	34.6	32.2	32.7	40.0	37.2	40.3	36.7	36.0
Broncho-pneumonia	.....	.....	.....	....	.....	19.2	17.9	23.9	31.9	27.9
Infantile diarrhea	61.8	58.7	61.4	54.2	44.4	74.4	44.2	43.0	43.9	23.9
Paralysis (unspecified	31.8	22.7	.....	21.3	21.2	20.7	20.3	19.0	21.5	19.1
Typhoid Fever	29.7	29.0	31.5	25.2	18.7	.....	.....	.....	.....	.....
Diphtheria	20.2	.....	.....	....	.....	.....	.....	.....	.....	.....
Diseases of the stomach	20.0	.....	35.3	....	.....	.....	.....	.....	.....	.....

	1917	Ratio	1916	Ratio
Entire province	33,284	12.0	33,580	12.8
Cities	13,535	13.1	14,287	14.0
Towns	2,493	14.7	2,609	16.5
Rural municipalities	17,256	10.9	18,684	11.7

tion of the United States) from all causes numbered 1,096,436. This represents a rate of 12.9 per 1,000 of population. The total number of deaths and the death rate of certain of the more important causes together with the percentage which each cause of death contributed to the total, is shown in Table III.

The proportion of these deaths classified as preventable and non-preventable can be readily estimated in the light of our present knowledge.

A further consideration of causes of death and a comparison of urban and rural deaths, is possible by reference to Table IV, which shows the deaths registered in the Province of Ontario for the years 1908 to 1917 inclusive. Further the ratio per 1,000 of population in cities, towns and rural municipalities is also shown (cities having a population of 10,000 and upwards, towns a population of 2,000 to 10,000; rural municipalities a population of less than 2,000).

Tables V and VI are shown separately because while they illustrate certain of the facts elicited by a consideration of Table IV, they do something more. They bring out in a striking fashion the effect of such a tragic event as the pandemic occurrence of one of the communicable diseases. Influenza, in the year 1918, headed the list of the causes of death, and in the Province of Ontario

TABLE V

DEATHS FROM ALL CAUSES—ONTARIO, 1918
TOTAL—43,038
RATIO—15.3 PER 1,000 OF POPULATION

LEADING CAUSES OF DEATH	
Influenza	7,337
Organic heart disease	5,252
Pneumonia	4,660
Tuberculosis	2,519
Cancer	2,103
Infant deaths (children dying during first 12 months of life)	6,402
Cardiovascular, renal conditions	1,521

TABLE VI

	1918	RATIO	1917	RATIO
Entire province	43,038	15.3	33,284	12.0
Cities	18,771	17.3	13,535	13.1
Towns	3,241	21.7	2,493	14.7
Rural municipalities	21,026	13.4	17,256	10.9

caused a rise in the death-rate from 12.0 per 1,000 of population (the figures of 1917) to 15.3. The 1919 rate is even less than that of 1917, being 11.9 per 1,000.

Table V shows too the great part which infant deaths (children under 1 year) play in contributing to the total mortality. In 1918 there were 6,402. This will receive further consideration when the question of infant mortality and child hygiene are dealt with.

Death statistics for the Dominion of Canada, including all the provinces have not as yet been issued, but certain data have been obtained through the courtesy of Mr. E. S. MacPhail, of the Bureau of Statistics. In the various provinces the deaths registered in each were as shown in Table VII.

TABLE VII

PROVINCE	YEAR
Prince Edward Island	743
Nova Scotia	9,200
New Brunswick	......
Quebec	35,170
Ontario	34,010
Manitoba	6,584
Saskatchewan	8,668
Alberta	5,507
British Columbia	4,888
	(to June 30, 1920)

A list of the causes of death for the whole Dominion for 1919 is not, as yet, available.

It will be appreciated that this data demonstrates clearly that certain preventable causes of deaths present obvious points of attack. Most of the communicable diseases may, through the application of appropriate measures, be expected to yield satisfactory results, by diminishing in number. Similarly some of the causes of deaths in early infancy, also deaths due to maternity, and directly or indirectly to the venereal diseases will be worth dealing with intensively.

It should not be inferred that cancer and other important causes of death which, for the time being, we regard as mainly nonpreventable should receive no consideration. On the contrary, it is hoped that, as a result of frequent physical examinations especially during the fifth, sixth and seventh decades of life, many such disorders

will be diagnosed in their incipiency, and prevented or at least be definitely retarded in their progress.

One aspect only of the work in preventive medicine has so far been dealt with. That is the prevention of preventable deaths. Now there is another very important part of the work and *that is the prevention of preventable sickness, physical and mental.* Unfortunately there are no adequate morbidity statistics. The total volume of sickness, and the amount due to various causes can only be estimated in a very general way.

Frankel and Dublin concluded as a result of sickness surveys conducted in Rochester, N. Y., Trenton, N. J., and in North Carolina in 1916 that between 2 and 3 per cent of the population investigated at ages 15 and over are constantly sick, and in 80.4 per cent the illness is serious enough to render them unable to work.

TABLE VIII

DISEASES	NO. OF CASES	PROPORTION PER 1,000 CASES
Influenza	386	76.1
Tuberculosis (all forms)	62	12.2
Organic heart disease	112	22.1
Anemia	202	39.8
Bronchitis, broncial and nasal catarrh, cold, etc.	902	181.3
Pneumonia and other Diseases of the Respiratory system	351	69.2
Diseases of the digestive system	726	143.1
Diseases of the genitourinary system	144	28.4
Diseases of the nervous system and special sense	340	67.0
Skin diseases	239	47.1
Injuries and accidents	308	60.7
Abscess, boils and other septic conditions	249	49.1
Lumbago, Rheumatism, etc.	336	66.3
Debility, neuralgia and headache	285	56.0
Other diseases	414	81.6
Total	5,074	1,000.0

Sir George Newman in his recent memorandum has considered this question and in Table VIII presents data indicating the chief conditions of sickness and disease for which patients have sought medical advice. This has been compiled from the data of 5 representative insurance practices in 5 large towns of England in 1916 and records the provisional diagnosis made of each patient.

TABLE IX

DISEASE	NUMBER OF CASES	PROPORTION PER 1,000 CASES
Tuberculosis (all forms)	796	41.2
Cancer, malignant disease	975	50.4
Organic heart disease	1,046	54.1
Other diseases of the circulatory and lymphatic system	386	20.0
Bronchitis	262	13.6
Pneumonia and other respiratory diseases	1,244	64.3
Diseases of digestive system	4,188	216.6
Diseases of genitourinary system	1,255	64.9
Gynecologic diseases	1,084	56.1
Diseases of nervous system and special sense	2,929	151.4
Skin diseases	553	28.1
Injuries and accidents	1,301	67.3
Acute inflammations	925	47.9
Chronic inflammations	297	15.4
Infectious diseases	598	30.9
Nephritis and Bright's disease	222	11.5
Congenital debility, etc.	349	18.1
Orthopedic	222	11.5
Other diseases	709	36.7
Total	19,341	1,000.0

Another interesting table (IX) shows the principal conditions of sickness for which patients were admitted to the wards of one of the London hospitals in 1913.

Table X shows the total number of admissions to the Toronto General Hospital for the year 1917-18 (omitting the Military Division) and a summary of the medical and surgical and other conditions for which they entered hospital.

These facts, of course, shed but little light on the question of the total volume of sickness in any community at any given time, because no account is taken of the persons who are sick in the home, many of whom may receive no medical attention of any kind. Furthermore, data dealing with those suffering from mental diseases have not been considered here. This aspect of the subject will be dealt with in the section dealing with mental hygiene.

If it is difficult to arrive at any definite conclusion as to the volume and kind of sickness, constantly existent, it is an even more difficult task to determine the economic cost of sickness. It may be noted, however, that Frankel and Dublin, in the studies above mentioned, estimated that about nine working days per person per year in the entire population, are lost as a result of sickness.

Since the communicable diseases constitute a large proportion

TABLE X

ADMISSIONS TO THE TORONTO GENERAL HOSPITAL 1917-18.	
Medical division	2,216
Surgical division	4,325
Obstetrical division	1,323
Ear, nose and throat division	2,093
Eye division	248
Total	10,205
SUMMARY OF MEDICAL CASES	
Nervous	256
Respiratory	176
Cardiovascular	165
Alimentary	223
Genitourinary	118
Skin	40
Blood and glands	61
Infective	838
Constitutional and miscellaneous	339
Total	2,216
SUMMARY OF SURGICAL CASES	
Skin and subcutaneous tissue	495
Bones	430
Joints and bursæ	108
Muscles and tendons	48
Glands	277
Blood, respiratory and cardiovascular	—
Constitutional, infective and miscellaneous	183
Nervous	79
Gastrointestinal	1,324
Female genitourinary	1,127
Male genitourinary	254
Total	4,325
SUMMARY OF OBSTETRIC CASES	
Obstetric	1,323
SUMMARY OF EYE DIVISION	
Eye	248
SUMMARY OF EAR, NOSE AND THROAT	
Ear	135
Nose	563
Throat	395
Total	1,093

of the deaths which may be regarded as preventable, these will next be considered. Table XI shows the deaths due to the more important communicable diseases in the Province of Ontario for the years 1908 to 1918 inclusive, and in addition there is given an estimate of the population for each year.

It is interesting to note the number of cases of each of the more

TABLE XI

YEAR	POPULATION	SMALLPOX	SCARLET FEVER	DIPHTHERIA	MEASLES	WHOOPING COUGH	TYPHOID FEVER	TUBERCULOSIS
1918	2,711,620	2	84	335	95	305	208	2,129
1917	2,769,850	1	59	396	58	228	232	2,014
1916	2,776,886	5	49	461	411	341	335	2,148
1915	2,767,350	2	42	341	145	193	298	2,088
1914	2,749,840	1	111	443	61	196	358	1,982
1913	2,677,600	4	137	339	166	272	446	1,955
1912	2,582,500	2	152	371	111	419	483	1,921
1911	2,523,274	3	290	427	169	169	637	2,035
1910	2,239,621	2	237	435	304	186	706	2,013
1909	2,233,264	3	200	430	167	262	669	2,017
1908	2,226,860	[illegible]	163	450	38	246	662	2,129

TABLE XII

PROVINCE OF ONTARIO

CASES OF, AND DEATHS FROM, COMMUNICABLE DISEASES

CAUSE	CASES REPORTED	
	1918	1919
Smallpox	435	3,027
Scarlet fever	2,900	3,749
Diphtheria	3,193	4,261
Typhoid fever	797	492
Tuberculosis of lungs	2,112	2,334
Infantile paralysis	34	49
Cerebrospinal meningitis	119	131
Measles	9,431	1,988

TABLE XIII

INCIDENCE OF COMMUNICABLE DISEASES REPORTED TO THE PROVINCIAL BOARD OF HEALTH OF ONTARIO, FOR THE YEAR 1920

DISEASES	CASES
Smallpox	5,169
Scarlet fever	5,130
Diphtheria	5,940
Measles	15,423
Whooping cough	2,042
Typhoid fever	714
Tuberculosis	2,259
Infantile paralysis	37
Cerebrospinal meningitis	77
Influenza and pneumonia	24,284
Primary pneumonia	
Syphilis	1,740
Gonorrhea	2,158
Chancroid	82

important communicable diseases reported during the three years 1918, 1919, and 1920. They are shown in Tables XII and XIII.

Remember that not all the cases of these diseases are reported even though notification is required by law. Many cases are not seen by any physician, and some of those that are seen are not reported. It is, therefore, difficult to determine what the actual incidence or prevalence of these diseases is, but in the State of New York it has been estimated that about 80 per cent of cases of diphtheria are reported. Whether this holds true for other notifiable diseases is not known. It is quite safe to conclude, therefore, that our morbidity records for even communicable diseases are far from being complete or satisfactory.

In considering the communicable diseases it is understood that they include all those conditions formerly designated infectious or contagious. The term "communicable" is regarded as being more suitable, and while it does not suggest the mode of transmission of any diseases, it does connote certain very definite characteristics common to them all. These communicable diseases are under suitable circumstances easily transmitted from one person to another, and are probably all caused by living agents; (microorganisms) bacteria or protozoa or minute forms of life of unknown nature, the so-called viruses. Then these diseases are unusual in that they have a definite incubation period; this is the time which elapses between the entrance of the living agent into the body and the first appearance of the symptoms of the disease. The individual suffering from such a disease is usually a source of danger to other persons with whom he may come in contact, if these latter are susceptible to infection. That is, they are in a state such that the causative agent, if it gains access to their bodies, will multiply and proceed to bring about a condition characteristic of the particular disease process. Another important attribute of a communicable disease is this: It is required that its occurrence shall be notified to the local health authority who directs that the movements of the sick person shall be regulated for the duration of the illness. That is, notification, isolation (separation of the patient from others who might contract the disease) and certain other public health regulations must be observed. As a rule during the illness and after the patient recovers certain measures are carried

out to prevent disease being transmitted to others. This is disinfection. When it is carried on during the course of the illness it is known as *concurrent disinfection.* If only practiced after the death or recovery of the patient, it is designated *terminal disinfection.*

Two other devices are utilized for the protection of other members of the community from an attack of a communicable disease. One is quarantine. This consists in limiting freedom of movement for a given period of time, of persons with any such disease, or others who have been in intimate contact with the patient. These latter individuals are known as *"Contacts."* Quarantine may be employed on land, one country against another; (it may also be carried out at seaports, in countries separated by water, when it is called maritime quarantine); or one province or state against another or others; one city or municipality against one or several others; and finally families or individuals may be quarantined. The exact application of this measure differs in various diseases and will be considered in detail in connection with those diseases. The other measure consists in putting a placard on the building (unless it is a hospital or place especially designed for the reception of such patients) indicating that a case of one of the communicable diseases is lodged in the building. This serves as a warning to others to avoid contact with the sick person. Some sort of classification of these diseases facilitates their study, and their separation into groups *according to their mode of transmission* is probably as satisfactory as any other purely arbitrary method of grouping.

It then happens that those diseases, the etiological agents of which are transmitted from the sick to the well, by the transfer of the secretions of the mouth, nose or throat, constitute the first group. This Group A includes:

Tuberculosis
Pneumonia (all forms)
Influenza
Diphtheria
Measles
Scarlet Fever
Whooping Cough
Cerebrospinal Meningitis
Anterior Poliomyelitis
German Measles
Mumps

This first group, it is estimated, includes about 90 per cent of all the cases of communicable diseases in those temperate climates where insect-borne diseases are practically nonexistent. Such communities as, for example, the Canadian provinces and the northern tier of states in the United States.

The second important group of communicable diseases are those in which the causative microorganism is transmitted from one individual to another in food or drink. In these diseases the germs are given off by the sick persons or by carriers in the excreta, feces or urine or both. From this excreta they in some way gain entrance into, or are transferred to water or food, and are then swallowed by other human beings. In this Group B are included:

Typhoid Fever,
Paratyphoid Fevers,
Dysentery, (Amebic and Bacillary)
Asiatic Cholera,
Infantile Diarrhea,
Hookworm Diseases (sometimes).

These diseases usually manifest themselves by symptoms due to disturbances in the gastrointestinal tract. None of the germs causing these diseases are especially resistant, and if all food and drink could be sterilized, or indeed subjected to a process like pasteurization, they would soon cease to exist. The germs of these diseases, then, must be eaten, so to speak, before they find a suitable lodging place in the body.

The third group of communicable diseases are the so-called insect-borne diseases. These include Group C:

Malaria,
Yellow Fever,
Typhus Fever,
Bubonic Plague,
Dengue Fever,
Rocky Mountain Spotted Fever,
Trypanosomiasis,
Kala-Azar, etc.

These conditions can be transmitted only through the intermediation of some species of insect, which transfers the infective agent

from the sick person to the well. In some of these diseases the parasite undergoes a definite cycle of development both in man and in the insect-carrier, or vector. In such instances it is spoken of as *biological transmission.* In certain other of these diseases the causative agent undergoes no change in the body of the insect. This is designated *mechanical transmission.*

These insect-borne diseases are most prevalent in tropical and semitropical countries; and viewed from the standpoint of international public health, they are extremely important. Malaria is one of the greatest single causes of death, if all deaths throughout the entire world are considered.

The next considerable group are those transmitted by contact, and of these the most important are the venereal diseases, Group D.

Syphilis,
Gonorrhea,
Chancroid.

Then the fifth group, Group E, would include diseases of unknown etiology, for which, however, there is a specific method of prevention. This includes:

Smallpox (if it is not included in the first group)
Rabies.

This grouping is not based on the mode of transmission.

There is another group in which infection is transferred to men by the entrance of germs found commonly in soil, (though their habitat is really the intestinal tract of lower animals). Such germs give rise to:

Group F. Tetanus,
Gas-Gangrene,
Anthrax, etc.

Certain other diseases caused by living agents and readily transmissible which have not been included in any of these categories are: erysipelas, transmitted by actual contact, puerperal fever, etc. This is a miscellaneous group and at the present time, so largely controlled by the application of the principles of aseptic surgery and aseptic nursing that they may be regarded as conquests of applied bacteriology.

In the following pages, each of the communicable diseases considered will be dealt with from the standpoint of: *incidence, etiology, modes of transmission and methods of control*—including the public health regulations ordinarily employed to prevent their spread. *Disinfection* will also be discussed in the case of each individual disease, insofar as it is required or found useful.

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CHAPTER II

DIPHTHERIA

Diphtheria, more than any other communicable disease, should within the next few years be adequately controlled if we are able to apply the very complete and comprehensive knowledge we now possess. For this reason it will be considered first.

Diphtheria as a cause of death still ranks high. Between 1 and 1.5 per cent of all deaths are due to this disease. This is all the more remarkable when it is realized that for 30 years we have understood (a) the cause of the disease: (b) how it is spread, and have possessed a specific method of treatment and prevention. During the last eight or nine years, we have also known a satisfactory method of determining which persons in the community are susceptible to infection and which are immune. And finally, we have a method of active immunization, the general application of which it is hoped will prove of the greatest benefit to the community. It is now greatly agreed, however, that the complete control of a communicable disease like diphtheria is very difficult of accomplishment. Primarily because the great majority of people are not possessed of the elementary though essential facts, which make it possible to have cases of the disease recognized in every instance at the onset. With this earlier recognition, limitation of the spread of the disease would be simpler, and appropriate treatment of the patients at such a time would mean fewer diphtheria deaths.

Etiology

Diphtheria is due to the invasion of a specific microorganism, B. diphtheriae. (Klebs-Loeffler, 1884.) This germ, (in common with B. tetani and B. botulinus) is able to elaborate a toxin which is diffused out into the medium in which it is growing, and is a classical example of a so-called exo-toxin. This bacillus when it invades the body, grows locally on mucous surface or on the skin, and gives off its toxin which has a very harmful effect on certain

body cells, particularly those of the heart, nerves, kidneys, adrenals, etc. The poison, (toxin) entirely freed from the germs which produce it, if injected into animals is capable of producing the same series of changes as the germs themselves.

Incidence

An increase of knowledge relating to diphtheria has not, unfortunately, been accompanied by a corresponding diminution in the prevalence of the disease. In a comprehensive statistical study of diphtheria, Crum has pointed out that "notwithstanding the great reduction in the diphtheria death rate as a direct result of antitoxin, better diagnosis, more general hospital care, etc., diphtheria is still responsible for at least 3 per cent of the total mortality at ages under fifteen years in the countries of the temperate zones for which reliable vital statistics are available."

He has also shown the comparative mortality from *diphtheria, whooping cough, measles* and *scarlet fever* in the registration area of the United States for the years 1910 to 1914, in Table XIV.

TABLE XIV

COMPARATIVE MORTALITY FROM DIPHTHERIA AND CROUP, WHOOPING COUGH, MEASLES, AND SCARLET FEVER. REGISTRATION AREA, U. S., 1910-1914

	DIPHTHERIA AND CROUP			WHOOPING COUGH		
AGE	DEATHS	PERCENTAGE DISTRIBUTION BY AGE	PERCENTAGE OF TOTAL DEATHS, ALL CAUSES	DEATHS	PERCENTAGE DISTRIBUTION BY AGE	PERCENTAGE OF TOTAL DEATHS, ALL CAUSES
Under 5 yrs.	35,691	62.2	3.3	30,074	95.2	2.8
5- 9 "	14,871	25.9	16.0	1,167	3.7	1.3
10-19 "	4,497	7.8	2.8	175	0.5	0.11
20 and over	2,355	4.1	0.08	179	0.56	0.01
All ages	57,414	100.0	1.34	31,595	100.0	0.74
	MEASLES			SCARLET FEVER		
Under 5 yrs.	23,649	80.6	2.2	13,685	53.9	1.3
5- 9 "	2,446	8.3	2.6	7,176	28.3	7.7
10-19 "	1,233	4.2	0.8	2,881	11.4	1.8
20 and over	2,001	6.8	0.07	1,632	6.4	0.05
All ages	29,329	100.0	0.68	25,374	100.0	0.59

The distribution of mortality in urban and rural areas is shown in Table XV.

The total number of cases reported in the province of Ontario

TABLE XV

MORTALITY FROM DIPHTHERIA AND CROUP IN THE REGISTRATION AREA OF THE UNITED STATES WITH DISTINCTION OF URBAN AND RURAL AREAS, 1910-1914

	URBAN*			RURAL		
YEAR	POPULATION	DEATHS	RATE PER 100,000	POPULATION	DEATHS	RATE PER 100,000
1900	10,675,611	5,591	52.4	9,289,538	2,465	26.5
1901	11,188,101	4,816	43.0	9,118,942	1,966	21.6
1902	11,477,929	4,568	39.8	9,171,012	1,560	17.0
1903	11,754,911	4,878	41.5	9,235,930	1,638	17.7
1904	12,029,302	4,623	38.4	9,307,413	1,634	17.6
1900-04	57,125,854	24,476	42.8	46,122,835	9,263	20.1
1905	12,372,228	3,712	30.0	9,364,680	1,408	15.0
1906	18,195,041	5,815	32.0	15,640,988	3,076	19.7
1907	18,737,525	5,493	29.3	15,871,371	2,873	18.0
1908	20,417,270	5,455	26.7	18,288,591	3,021	16.5
1909	23,066,405	5,632	24.4	21,215,280	3,182	15.0
1905-09	92,788,469	26,107	28.1	80,380,910	13,560	16.9
1910	25,187,805	6,482	25.7	22,619,961	3,608	16.0
1911	27,485,457	5,883	21.4	26,899,777	4,075	15.1
1912	28,129,824	5,502	19.6	27,122,299	4,207	15.5
1913	29,244,160	6,324	21.6	29,068,435	4,280	14.7
1914	30,287,640	6,320	20.9	30,826,560	4,243	13.8
1910-14	140,334,886	30,511	21.7	136,537,032	20,413	15.0

*By urban is meant all municipalities of 10,000 or more population.

for the year 1920 is greater than at any time since diphtheria was made a notifiable disease—twenty years ago. Between the years 1895 and 1918 there was in Ontario, as in many other parts of the world, a very satisfactory reduction in the number of diphtheria deaths. This condition of affairs, however, has not continued, and in 1919, the diphtheria deaths in Ontario rose from the 1918 figure of 335 to 475, and the first estimate of the 1920 figure gives the number of deaths as over 650, almost double the number registered in 1918. The indication in 1919 that there was evidently a rising tide in the diphtheria mortality led me to undertake a study of the factors concerned in diphtheria deaths. This preliminary study has shown that the most important single factor contributing to the continuance of these preventable deaths is neglect of early treatment.

Figures to illustrate the diphtheria mortality in the province of Ontario for the thirty-eight year period are shown in Table XVI.

The next table indicates the number of cases reported each year from 1900 to 1919. The 1920 figure would show a still higher incidence than that of 1919.

TABLE XVI

DEATHS FROM DIPHTHERIA AND CROUP—ONTARIO

YEAR	TOTAL DIPHTHERIA DEATHS
1880	1,251
1881	1,704
1882	1,708
1883	976
1884	929
1885	1,282
1886	1,833
1887	1,786
1888	1,459
1889	1,101
1890	893
1891	952
1892	890
1893	1,044
1894	1,075
1895	942
1896	925
1897	976
1898	634
1899	599
1900	738
1901	772
1902	676
1903	687
1904	608
1905	503
1906	423
1907	380
1908	450
1909	430
1910	435
1911	423
1912	371
1913	339
1914	443
1915	341
1916	461
1917	396
1918	335

There are certain other important facts in regard to incidence. It is a disease which in nearly all temperate climates is present in *endemic* form, (a certain number of cases being observed each year). Occasionally, however, it tends to become *epidemic*, (a much larger number of cases than usual coming under observation in a brief period of time). It does not, however, tend to manifest itself definitely in *pandemic* fashion, (showing a great increase in the number of cases and spreading from one country to another, over the entire

TABLE XVII

YEAR	PERCENTAGE OF TOTAL DEATHS (ALL CAUSES)
1880	6.3
1881	7.4
1882	8.2
1883	4.7
1884	4.3
1885	5.9
1886	8.0
1887	7.6
1888	6.1
1889	4.7
1890	3.7
1891	4.4
1892	3.8
1893	4.5
1894	4.7
1895	4.2
1896	3.7
1897	3.6
1898	2.4
1899	2.1
1900	2.5
1901	2.7
1902	2.5
1903	2.4
1904	2.0
1905	1.7
1906	1.3
1907	1.1
1908	1.1
1909	1.3
1910	1.3
1911	1.3
1912	1.1
1913	0.98
1914	1.3
1915	1.0
1916	1.2
1917	1.1
1918	0.77

world in a comparatively short space of time). Nor, on the other hand is it usual for the disease to be *sporadic,* (occasional cases seen only at infrequent intervals of time). Why it tends to become epidemic and ceases to be endemic, is not clear at the present time. The prevalence of any of the communicable diseases, may be profoundly influenced by such factors as *age, sex, social status, season of the year,* or *climatic conditions.*

Diphtheria has a very characteristic *seasonal incidence* (period of

TABLE XVIII

DEATHS FROM DIPHTHERIA AND CROUP—ONTARIO

YEAR	RATIO PER 100,000
1880	66.0
1881	88.6
1882	87.4
1883	49.7
1884	48.3
1885	64.1
1886	90.8
1887	87.6
1888	71.0
1889	53.0
1890	42.6
1891	45.0
1892	41.9
1893	49.0
1894	50.3
1895	43.9
1896	43.1
1897	44.8
1898	29.3
1899	29.0
1900	33.0
1901	35.3
1902	30.5
1903	30.5
1904	26.6
1905	21.6
1906	17.5
1907	15.9
1908	18.5
1909	17.5
1910	17.4
1911	16.7
1912	14.5
1913	13.0
1914	16.8
1915	12.8
1916	17.1
1917	14.5
1918	12.0

the year when the disease is more prevalent). There are as a rule more cases of diphtheria during the fall and winter months (October to May) than at other times. The increase in the number of cases of diphtheria reported synchronizes with the opening of the schools in the fall of the year. Finally, there is a very constant age incidence. This is due probably to a variation in the degree of susceptibility at different ages. Since the susceptibility of individuals can be accurately determined by means of the Schick test, definite informa-

tion is now available on this point. Park gives Table XIX to show susceptibility of persons at various ages, to diphtheria.

TABLE XIX

SHOWING SUSCEPTIBILITY OF PERSONS OF VARIOUS AGES TO DIPHTHERIA, AS INDICATED BY THE SCHICK TEST IN OVER 20,000 PERSONS (PARK)

AGE	AVERAGE SUSCEPTIBLE PER CENT	PER CENT VARIATION IN RANGE OF POSITIVE SCHICK REACTIONS
At Birth	10	0 - 15
Under 4 months	15	0 - 15
4 to 6 months	30	20 - 30
6 to 9 months	60	60 - 74
9 to 1 year	75	65 - 75
1 to 2 years	75	60 - 76
2 to 3 years	65	50 - 70
3 to 5 years	40	15 - 50
5 to 10 years	30	8 - 40
10 to 20 years	25	5 - 40
Over 20 years	20	5 - 42

The Schick test by means of which susceptibility or immunity to diphtheria is determined, is carried out in the following manner. A fresh solution of diphtheria toxin is prepared for this purpose of such strength that 0.2 c.c. represents $\frac{1}{50}$ of the minimum lethal dose of toxin for a 250 gram guinea-pig. This amount is injected with a good syringe, preferably a 1 c.c. "Record," and a fine steel or platinum-iridium needle, intracutaneously, on the flexor surface of the forearm or arm. A good guide for the insertion of the needle into the proper layer of the skin is to see the oval opening of the needle through the superficial layers of the epidermis. An injection properly made can be recognized by the distinct wheal-like elevation, which shows the prominent openings of the hair-follicles. The result of the test should be read at the end of twenty-four, forty-eight, seventy-two, and ninety-six hours, and finally observed after fourteen days.

The reaction that appears at the site of injection may be either (*a*) *positive*, (*b*) *negative*, (*c*) *pseudo*, or (*d*) *combined* positive and pseudo. The positive reaction represents the action of an irritant toxin upon tissue cells that are not protected by antitoxin. It indicates, therefore, an absence of immunity to diphtheria. A trace of redness appears slowly at the site of injection in from twelve to

twenty-four hours, and usually a distinct reaction in the course of twenty-four to forty-eight hours. The reaction usually reaches its height on the third or fourth day, it may, however, be as late as the fifth or sixth day and gradually disappear, leaving a definitely circumscribed scaling area, or brownish pigmentation, which persists for 3 to 6 weeks. At its height, the positive reaction consists of a circumscribed area of redness and slight infiltration, which measures from 1 to 2 cm. in diameter. The degree of redness and infiltration varies to a great extent with the relative susceptibility of the individual. The percentage of positive reactions in individuals of different age periods is indicated in the table given above.

In the negative reaction the skin at the site of injection remains normal. The negative reaction definitely indicates an immunity to diphtheria if the test toxin is of full strength, has been freshly diluted, and the injection has been made into the proper layer of the skin. A negative reaction obtained in a child that has reached the age of 3 years indicates that it has an immunity which is probably (in 90 per cent of people constant, and may be) permanent. In a large series of cases observed by Park and Zingher only two individuals developed clinical diphtheria, when they were exposed to the disease after having given a negative Schick test.

The pseudoreaction represents a local anaphylactic response of the tissue cells to the protein substance of the autolyzed diphtheria bacilli, which is present in the toxin broth used for the test. Like other anaphylactic skin phenomena, the reaction is of an urticarial nature, appears early, within six to eighteen hours, reaches its height in thirty-six to forty-eight hours and most often disappears about the third or fourth day, leaving a poorly defined small area of brownish pigmentation and generally no scaling. At its height the pseudoreaction shows varying degrees of infiltration, and appears as a small central area of dusky redness with a secondary areola, which gradually shades off into the surrounding skin. The reaction may also have a rather uniform red appearance and be 2 or 3 times the size of a true reaction. A control test is made by injecting a similar quantity of toxin heated to 75° C. for 5 minutes, this heating destroying the toxin, so that the reaction in such cases is due to the injection of foreign protein, and not to the specific irritant action of the toxin on tissue cells of an unprotected person. Individuals who give a pseudoreaction only, have natural antitoxin in

the blood and are immune to diphtheria. The false reaction is seen in relatively few older children, but in a much larger number of adults, in whom it is of importance to recognize and control it, both by the injection of heated toxin, and by observing the clinical course of the reaction.

The combined reaction represents the positive and the pseudoreaction in the same individual. The central area of redness is larger and better defined, the amount of filtration is also more marked. The reaction is recognized by noting the evidence of a true reaction, a definite area of scaling brownish pigmentation, after the pseudoelement has disappeared in the test. In addition, a similar though weaker reaction is obtained in a control test made with heated toxin. The control represents only the pseudoreaction. The combined reaction indicates an absence of immunity to diphtheria.

The Schick test is of practical value in determining the immunity to diphtheria of the public in general, but especially of the child population in schools, hospitals, institutions and in homes during an outbreak of diphtheria. It will save a considerable amount of antitoxin and avoid unnecessary sensitization of more than 65 per cent of the exposed individuals. The test is also of distinct value in the active immunization of susceptible individuals against diphtheria with mixtures of toxin-antitoxin, and in the diagnosis of clinically doubtful cases of diphtheria.

Modes of Transmission

Diphtheria is usually transmitted from one individual to another *directly* by the transfer of mouth and nose secretions containing the diphtheria bacilli. Such a transfer is effected by cases of diphtheria, or by diphtheria carriers (those harboring germs of the disease but not showing clinical manifestations). Such direct transmission occurs when infected persons spray fine droplets on those with whom they are in close contact (sometimes also called "droplet infection") by coughing, sneezing, spitting or speaking loudly. Such direct transfer is possible for distances under 4 feet. Another method is by the transfer of the secretion containing the germs, on the hands.

Diphtheria may also be transmitted *indirectly*, by objects soiled with secretions containing germs of the disease (such soiled objects

are sometimes called *fomites*) such as toys, lead pencils, and the like articles; or eating utensils and glasses, cups, etc., or towels, or personal linen carried by the fingers to the mouth or nose, of some susceptible individual. This permits of the germs gaining access to the body. While it is true that the diphtheria bacillus commonly inhabits the mucous membrane of the nose, throat, larynx, upper respiratory passages, and much less commonly the conjunctiva or vagina, it should be remembered that the skin may also be the site of election of the germ. An outbreak of skin diphtheria among wounded soldiers was described by the author, and, more recently, a slight epidemic outbreak of diphtheria of the ordinary clinical type, which originated in an undiscovered case of skin diphtheria has been reported.

Diphtheria like certain other communicable diseases, may be spread by the use of milk which has been accidently contaminated with the causative agent of the disease. This is what is called *milk-borne diphtheria.* Occasionally limited epidemics of diphtheria are due to the transmission of the germ in this way to those who obtain milk from a dairy where an infected person has handled the milk. Just recently (December, 1920) an outbreak has been reported by Henry.

Next in importance to patients suffering from diphtheria, (who have not yet been isolated,) and the second source of new cases of the disease, are the *carriers.* It is estimated that about 1 per cent of normal healthy individuals harbor B. diphtheriae in the nose or throat. However, the persons who are most likely to be dangerous carriers of the disease are those who have just recently recovered, or who have been in intimate contact with patients ill with diphtheria.

It is very important to know in the case of carriers, and patients who for some time after recovery harbor germs of the disease in their throats, whether such germs are virulent; that is whether they are active toxin producers. This can be determined by 2 laboratory tests, by means of so-called virulence and protection experiments. Recent convalescents, and contacts of actual clinical cases of the disease are most likely to harbor these virulent strains of B. diptheriae.

It is evident that the control of diphtheria (and this is true of other communicable diseases) is going to depend very largely upon

a thorough knowledge of the *sources* (persons infected with the germs of the given disease) and *modes of infection* (way in which the etiologic agent is passed from one person to another). Two or three observations which are of significance in this connection should here be noted. In diphtheria and in many other diseases due to germs, the variation in the severity of attack in different individuals is a matter of prime importance. Very mild cases of the disease may not be recognized. These are so-called *"missed cases."* Then there may be *atypical cases;* and finally in certain of these atypical cases the course of the disease may be so brief, and recovery so prompt, that the term *"abortive case"* is applied. These facts which are of great clinical interest are also of great moment from the standpoint of preventive medicine.

Control

Let us now turn to a consideration of the measures by which diphtheria may be controlled. An important preliminary point in diphtheria (this also is true in the other communicable diseases) is a knowledge of the length of the incubation period. In diphtheria this is believed to be from two to eight days. This fact is significant when we come to consider, as we do at this point, the question of *epidemiology* (a study of all the evidence obtainable, relating to the source of infection, the method by which the disease is transmitted, and the number of cases, etc.).

The physician, called to see any patient whose complaint is sore throat, or (as in laryngeal diphtheria) a child with a history of croup, should always have in mind the possibility of diphtheria. This is most essential in the case of little children. Remember that 65 to 80 per cent of deaths from diphtheria are in children under five years of age. This is true because the parents very frequently do not realize that the child is really ill because serious subjective symptoms are sometimes absent. Secondly, early diagnosis may not have been made by the physician. Therefore, every sore throat is potentially dangerous. It is not the purpose of this book to consider in detail symptomatology and all points in diagnosis of all the various diseases. But, in this connection, the physician should realize that the diagnosis will depend upon a careful correlation of the clinical findings, with the result of the laboratory examination of the swab taken from the nose and throat.

After such a careful clinical examination of the patient, this nose and throat swab should be taken and sent at once to the nearest diagnostic laboratory, for examination. If the diagnosis cannot be made for certain without the aid of the laboratory, the physician should be very careful to examine the throat at least every twelve hours, until the result of the laboratory examination is obtained. If there is reason to think that the case may be one of diphtheria, antitoxin should be given at once without waiting for the laboratory report. And never should a diagnosis be made on a laboratory report alone. In 6 instances, among the first 100 diphtheria deaths investigated by the author, a negative laboratory report was returned, but the cases died of diphtheria because antitoxin was not administered.

In the laboratory, the material on the swab, taken from the patient's throat is examined. If the material reaches the laboratory within 6 hours or less after it is taken: and if the swab has been properly applied by the physician (rubbed carefully over the mucous membrane of the throat, including the tonsils, uvula, etc., and, when necessary, over the mucous membrane of the nose, also, especial attention, of course, paid to any "spot" anywhere on the mucous membrane of the throat or tonsils) in a high percentage of cases, probably 85 to 95, B. diphtheriae, will be found in the cultures obtained from these swabs. If, however, the swab is taken improperly or inadequately, or if a lengthy period of time elapses before it reaches the laboratory, the result may be negative because the germs have died before being planted on culture media. The result of the examination under such circumstances will be negative, even when the swab has been taken from a clinically positive case of diphtheria.

It is most important to remember that *the physician makes the diagnosis not the laboratory.* The information obtained from the examination of the swab is only *part of the evidence* upon which the diagnosis should rest. This observation applies with equal force in the diagnosis of other communicable diseases where the physician submits material to a laboratory for examination in order that he may have as much data as possible upon which to base an opinion.

The patient who is seen and is even suspected of suffering from diphtheria should be *isolated at once.* This may be accomplished in the home if the facilities are such that complete separation of

the patient from other members of the family is possible. If such is not possible, the patient is better off in a hospital for communicable diseases, if there is one in the community, and admission thereto can be obtained. The patient will often benefit by being sent to the hospital. This is desirable not only for securing satisfactory isolation of the patient, but also that the patient may receive the benefit of adequate medical and nursing care, and to minimize the disturbance to ordinary family life. This has special force in large centers of population, and among those of very limited means.

That among hospitalized cases of diphtheria there is frequently a lower death rate, is illustrated in Table XX compiled from data supplied by the Isolation Hospital, Toronto.

TABLE XX

DEATHS FROM DIPHTHERIA, CITY OF TORONTO, 1912-1919

YEAR	CASES REPORTED	TREATED IN HOSPITAL	NOT ADMITTED TO HOSPITAL	HOSPITAL DEATHS	DEATHS AT HOME
1912	1,383	663	720	53	91
1913	895	569	326	35 (18)	33
1914	873	601	272	47 (11)	28
1915	746	537	209	35 (14)	27
1916	1,249	884	365	62 (30)	48
1917	1,445	1,124	321	47 (30)	35
1918	1,163	1,015	158	65 (25)	31
1919	2,132	1,327	805	96 (24)	72

The figures in parentheses indicate the proportion of these hospital cases who died within 24 hours after admission; having been admitted, very often, in a moribund condition. A similar observation was made by Kolmer in a study of diphtheria deaths in Philadelphia.

A partial explanation of the difference in results obtained when patients are treated in hospital is this. In many nonhospitalized cases there is much delay in calling a physician and very inadequate nursing care is provided.

The physician having isolated the case of diphtheria then *notifies in writing, the medical officer of health* of the case as required by law. The case should be reported on the day the patient is first seen, and it is important to remember that if the physician has "reason to suspect" the case is diphtheria he must report it anyway. Swabs of the nose and throat of all contacts of the patient should be taken and such contacts quarantined until two successive negative swabs have been taken. The medical officer of health or some

other member of the local health department placards the dwelling in which the patient lives (unless the case is sent to the hospital). It is sometimes the practice to give a small immunizing dose of 500 to 1,000 units of diphtheria antitoxin to all the immediate contacts of a case of diphtheria, and this practice has undoubtedly helped to control the spread of the disease. This probably should be done when the physician has not convenient access to a laboratory. If, however, such is available, and swabs from the nose and throat of the contacts, at the time when the patient is first seen, are found to be negative as a result of laboratory examination, it is unnecessary to give such a prophylactic dose of antitoxin. This, however, should be given if the results of the laboratory examinations are not received within twenty-four to thirty-six hours, or if the throat of any contact does not appear normal. The patient will then have to be isolated, the contacts quarantined, and the house placarded within a few hours after the patient is first seen. All these measures should limit the further spread of the disease. In many municipalities the health department will take further action if the disease is at all prevalent in the community, and such is desirable. These measures of isolation, quarantine and placarding are required also on the occurrence of cases of smallpox, leprosy, scarlet fever, bubonic plague, cholera, measles, anterior poliomyelitis, cerebrospinal meningitis, as well as in diphtheria.

Cases of whooping cough, mumps, chickenpox, tuberculosis, typhoid fever, influenza, encephalitis lethargica, and such diseases as anthrax, glanders, rabies and erysipelas are required to be notified and isolated, but usually quarantine and placarding is omitted.

The treatment of the individual case of diphtheria is of such great importance from the standpoint of preventive medicine that brief reference will here be made to the subject. The one matter of paramount significance in the prevention of diphtheria deaths is *early treatment*. No further factor is so important. The successful treatment of diphtheria with antitoxin is entirely contingent upon the patient's being given antitoxin at a sufficiently early period to prevent the fixation of the toxin to the various body cells. The neutralization of the toxin, once it has become firmly attached to such body cells, is impossible. Therefore, the general public through every possible channel must be made to understand that *successful*

treatment of diphtheria means early treatment. Kolmer in a statement regarding results obtained in the treatment of diphtheria in the Philadelphia Hospital for Contagious Diseases points out that in a series of 741 *"first-day" cases* (patients treated on the first day on which the symptoms of the disease were observed) *there was not one single death!* Table XXI indicates the death rate according to the duration of the disease when antitoxin was given.

TABLE XXI

CASE FATALITY: ACCORDING TO THE DURATION OF THE DISEASE WHEN ANTITOXIN WAS GIVEN. PHILADELPHIA, PA. 1910-1914. DEATHS PER 100 CASES.

First day	1.1
Second day	5.6
Third day	6.8
Fourth day	7.7
Fifth day	9.2
Sixth day	9.3
Seventh and later	11.4

The dose of antitoxin to be administered will vary according to (a) the age (weight) of the patient, (b) the duration of the disease and (c) the clinical type of the disease. The initial dose in any case should probably not be less than 5,000 units for a child and 10,000 units for an adult. In regard to the use of very large doses of antitoxin there is considerable difference of opinion. Park holds that a dose of from 5,000 to 50,000 units is adequate in all types

TABLE XXII

AMOUNT OF ANTITOXIN IN THE TREATMENT OF A CASE

	MILD CASES UNITS	EARLY MODERATE UNITS	LATE MODERATE AND EARLY SEVERE UNITS	SEVERE AND MALIGNANT UNITS
Infants 10 to 30 lbs. in weight under 2 years	2,000 to 3,000	3,000 to 5,000	5,000 to 10,000	7,500 to 10,000
Children 30 to 90 lbs. in weight under 15 years	3,000 to 4,000	4,000 to 10,000	10,000 to 15,000	10,000 to 20,000
Adults, 90 lbs. and over in weight	3,000 to 5,000	5,000 to 10,000	10,000 to 20,000	20,000 to 50,000
Method of administration advised	Intramuscular	Intramuscular	Intravenous	Intravenous

When given intravenously, the smaller amount stated.

of cases as indicated in Table XXII, where also is shown the modifications in dosage determined by the weight (of course, approximately) of the patient, and by the duration of the disease.

It is highly desirable that the quantity of antitoxin which the physician has decided to administer to any patient should be given in a single rather than in divided doses. It is not infrequently the practice to give 10,000 units when the patient is first seen, 10,000 units the next day and 10,000 units on the day following. Much better results may be expected if the *antitoxin is all given in one dose* and given at the earliest possible moment. The administration of diphtheria antitoxin, by intravenous injection, is of great value in those cases which are not seen by the physician until the patient has been ill for several days. It is also advisable in early cases which appear to be acutely toxic, and in cases of laryngeal diphtheria, especially those which may have gone untreated for several days. Antitoxin provided for intravenous use should be especially diluted with freshly prepared, sterile, physiological sodium chloride solution. (This preparation should be undertaken by the laboratory distributing the antitoxin.) Before injection the antitoxin should be warmed to body temperature, any air in the syringe and needle completely expelled, and the injection made very slowly. Any symptoms of collapse should be the signal for the immediate withdrawal of the needle. The remainder of the dose may under such circumstances be given subcutaneously or intramuscularly. Absorption of antitoxin is ten times as rapid after intravenous, and four times as rapid after intramuscular, as after subcutaneous injection. There is just one other point in connection with the question of dosage of antitoxin. It has been stated as follows, by Park: "The greater the quantity of antitoxin in the blood the more rapidly will an appreciable amount pass to the tissues."

The further treatment of the patient from the public health standpoint consists in determining whether the diphtheria bacilli have disappeared from the patient's nose and throat. This information is gained by taking swabs. Two successive negative cultures made from the patient not less than 12 days after the onset of the illness are required by the health department before quarantine is lifted. Throat swabs, for release of quarantine are required to be taken at least 24 hours apart.

The germ of diphtheria is not especially resistant to unfavorable conditions outside the body. It may, however, persist for some time in the throat of the individual who has recovered from the disease. In about 50 per cent of cases the bacilli disappear within 3 days after the disappearance of the membrane. But in a small percentage of cases it may be several weeks or months before they disappear. Such individuals contribute largely to our diphtheria-carrier population.

The control of outbreaks, on a large scale among the general population, or among the inmates of public institutions, is essentially the same. Notification, isolation, quarantine, swabbing, and under certain conditions the prophylactic use of diphtheria antitoxin, each has a place. But something more is necessary, and it is essential to indicate what may be adopted to control diphtheria.

It should be realized in the first place that the injection of a dose of 1,000 units of antitoxin for prophylactic purposes induces a *passive immunity only.* This will persist as long as some of this antitoxin remains in the body. It will be entirely eliminated, however, within from 10 days to 3 weeks after injection and then the person is no longer protected. It is impossible to continue indefinitely repeating this procedure of passive immunization, and fortunately this is now unnecessary. As a result of work by von Behring and Park and Theobald Smith, a satisfactory method of conferring a more durable type of immunity has been elaborated. Through the application of this principle an *active immunity* is aroused in the person treated, in contrast with the passive immunity conferred by the injection of diphtheria antitoxin. The distinction beween these two procedures is essentially this. In passive immunity, the protective substance (antitoxin) which has been worked up in the blood of the horse, is injected into man upon whom it confers protection as long as it remains in the body. This, however, is usually a very brief period, ten days to three weeks.

In active immunity on the other hand, the individual works up his own protection as a result of receiving three injections (usually one week apart) of a properly balanced mixture of diphtheria toxin and antitoxin in a dose of 1 c.c. on each occasion. After a period of from six to twelve weeks, 70 per cent of those who are given one dose of toxin-antitoxin mixture will give a negative Schick test, indicating immunity. If two injections are given 80 per cent of susceptible

persons will give a negative test, and if three injections, about *90* per cent. That is, the above percentage of susceptible individuals (as indicated by a positive Schick test before injection of the toxin-antitoxin mixture) will have developed antitoxin, and thereby protection as a result of the injections.

The active immunity so developed seems very permanent. Whether it persists throughout the whole life of the individual, is not yet known, but it seems probable. This method of active immunization is a most important addition to the others formerly available for the control of diphtheria. The method is especially applicable to children between the ages of six months and five years, because of the greater susceptibility to the disease at those ages. It is also of value for older children in institutions, orphanages, homes, etc., where they may be constantly exposed to infection. It would seem also to be indicated in adults in isolation hospitals, etc., who are frequently exposed to infection. In some communities it is being carried out voluntarily in school children, in large numbers. As yet it is not being done in any considerable number of instances in private practice, though there is probably no good reason why it should not.

As a preliminary to the injection of toxin-antitoxin mixture, the Schick test should, of course, be performed, and only those giving a *positive* or *combined* reaction, immunized. Those giving a negative or pseudoreaction are already immune. After active immunization (perhaps in eight to twelve weeks) it is well to repeat the Schick test, which should now be negative, and will be, if the individual has developed an immunity. This will indicate that diphtheria antitoxin has been produced and is probably present in the blood in a concentration of $\frac{1}{50}$ to $\frac{1}{30}$ of a unit per c.c. of blood.

The dose of toxin-antitoxin mixture (usually 1 c.c. given subcutaneously once each week, for 3 weeks) is the same for adults and for children 1 year old. For infants under 1 year of age, 3 doses of 0.5 c.c. each are given at intervals of 1 week.

Mention has now been made of practically all methods of value in the control of individual cases with the exception of disinfection. Both *concurrent* and *terminal* disinfection should be carried out in every case of diphtheria. Since the germ is not especially resistant and does not live long outside the body, it is evident that human beings are essentially the reservoirs of infection; and their mouth

and nose secretions (and occasionally, in skin infection, hands, etc.) the source of danger. Disinfection (which simply means the destruction by physical or chemical means of the infective agent) should be applied in diphtheria to the destruction of all useless articles wet with the patient's secretions. Soak in $1/40$ carbolic acid solution for 1 hour all linen, etc., and all articles soiled by the patient; subsequently boil for at least ten minutes. Beds, floors, walls, etc., may be washed down with hot water and soap. It is desirable to add to the hot water $1/80$ crude carbolic acid solution.*

In this way practically everything coming in contact with the patient and likely to be smeared with diphtheria bacilli, will have to be cleansed. The room should be thoroughly aired (after being scrubbed) and left uninhabited for a short period—a few days if possible—to permit the sunshine (if available) and pure air, by its drying effect, to complete the process of germ destruction.

If great care is exercised during the illness of the patient to destroy or disinfect secretions, etc., when they are first given off by the patient, not much will remain to be accomplished by terminal disinfection.

The method of applying gaseous disinfection (fumigation) in private houses using sulphur dioxide or a mixture of formalin and potassium permanganate to destroy all germs given off into the room or transferred to objects therein is not now as frequently employed as formerly. While it has a comforting psychic effect, the probability is that concurrent disinfection with thorough mechanical cleansing at the end of the illness accomplishes the same purpose. This is especially true in those diseases of which the causative agent is known and the modes of transmission well worked out.

In certain diseases fumigation or gaseous disinfection may be of very considerable merit and its application will be outlined in discussing the methods of control of such diseases.

In many communities, definite regulations for disinfection are laid down providing that certain procedures must be carried out during the progress of the illness, and at the termination of every

*Or the use of a solution such as:

Crude carbolic acid	– 1
Soft soap	– 2
Water	100

may be recommended.

case of a communicable disease. The physician should own a copy of the regulations covering disinfection under such circumstances.

The physician, where he is in attendance on a case of diphtheria in a private home, should give very special directions to the responsible member of the family in regard to the disposal of the secretions, etc. The room in which the patient is should contain as little as possible in the way of excess furniture, simply a bed, a cot for the attendant, (nurse or member of the family) where short rests may be enjoyed, and a small table for the items required in treatment, and the dishes which the patient should have for his exclusive use during his illness. These should be boiled for 1 or 2 minutes each time after use. The attendant and physician when in close contact with the patient should wear a gauze mask, properly prepared, (at least 4 to 6 layers of gauze, and covering both the mouth and nose) and also wear a gown, which should be left in the room where the patient is, when either nurse or physician are not with the patient. Careful washing of the hands and face after contact with the patient is highly important.

In diphtheria, almost more than in any other communicable disease, the control of carriers is a matter of the greatest importance. Up to the present time no absolutely specific method for this has been evolved. Removal of diseased tonsils and of adenoids, and the correction of deviations of nasal septa, etc., may in many instances result in the disappearance of the germ, because their lodging place has been removed or rendered unsuitable. Antitoxin is not a specific for the *permanent* relief of carriers because it does not kill diphtheria bacilli, it simply neutralizes any toxin they may produce.

If those who came into immediate contact with cases of diphtheria always exercised every precaution to avoid the conveyance of germs, by wearing gowns and masks, and if all contacts were separated as soon as a case was discovered, fewer carriers would be found.

Furthermore, if children were taught, at a very early age, to always wash their hands and faces, after being in public places, before coming into intimate association with younger children, or before taking food, fewer cases of the disease would arise in consequence of school attendance, etc. Then, of course, adequate medical and nursing service provided in all schools, while it will

not necessarily lessen the number of diphtheria deaths, should result in earlier detection of carriers, and result in their receiving prompt attention. Physicians, in the event of a patient's being held as a diphtheria carrier may request the laboratory to undertake *virulence* and *protection* tests, which will reveal whether or not the germ is a toxin producer and whether the patient will be a menace to others if permitted his freedom.

Since antitoxin plays such an important part in the control of diphtheria and since in a large percentage of cases unpleasant *reactions* may follow its injection, just a word will be said here about these.

Diphtheria antitoxin is contained in horse serum, the proteins of which are alien or foreign proteins for man, and will in a considerable proportion (even as high as 40 per cent) of cases produce local or general reactions. These are not due to the antitoxic qualities of the serum, but to the horse serum proteins, normal horse serum produces them as frequently as antitoxic serum. Local reactions are characterized by the immediate appearance (within a few hours) or, after a lapse of about 8 days, of a rash, or occasionally edema of some part of the body, or pain in the joints, etc. These are symptoms of what is called serum sickness and are an instance of the phenomenon of anaphylaxis—a condition of sensitization. These are often most unpleasant, but usually not serious reactions. They should be anticipated, and when they appear their nature should be explained to the patient or to the family. They are usually quite transient. No specific remedy for the alleviation of these conditions is known.

Occasionally general reactions of a more serious and severe character follow the intravenous injection of antitoxin. In about 1 patient in 70,000 in New York City death has followed the use of diphtheria antitoxin. In every instance the fatal result has been observed in asthmatic individuals who have an abnormal susceptibility to horse serum proteins. This seems to be a congenital defect and asthmatic persons should be given serum only after being warned, and after desensitization is attempted (the injection very slowly of a small fraction of 1 cubic centimeter of horse serum subcutaneously before antitoxin is administered). Deaths following the administration of antitoxin are probably not more frequent than deaths from anesthetics, and neither seem to be entirely avoid-

able at the present time. The deaths which have followed antitoxin administration have practically all been in persons who have received antitoxin for the first time. The incidence of complications among cases of diphtheria is a matter of much importance.

TABLE XXIII

INCIDENCE OF COMPLICATIONS AMONG COMPLETED DIPHTHERIA CASES, 1905-1914. METROPOLITAN ASYLUMS BOARD, LONDON, ENGLAND

COMPLICATIONS	NUMBER	NUMBER PER 1,000 DIPHTHERIA CASES
Albuminuria	12,369	250.9
Paralysis	6,135	124.4
Otitis	2,371	48.1
Scarlet Fever	2,203	44.7
Adenitis*	1,658	33.6
Bronchopneumonia	593	12.0
Measles	436	8.8
Relapse of disease	419	8.5
Chickenpox	347	7.0
Nephritis	299	6.1
Pneumonia, lobar and unqualified	225	4.6
Whooping cough	202	4.1
Rubella	106	2.2
Mastoid abscess	56	1.1
Mumps	36	0.7
Tonsillitis	11	0.2
Erysipelas	10	0.2
Jaundice	3	0.1
Tuberculosis	2	0.1
Bronchitis	1	0.0
Enteric fever	1	0.0
Influenza	1	0.0
Stomatitis	1	0.0
Total complications	27,485	557.4
Total completed cases	49,308	.....
*Adenitis	1,658	33.6
Suppurative adenitis of acute stage	176	3.6
Suppurative adenitis of convalescence	230	4.7
Simple adenitis of convalescence	1,252	25.3

Crum has compiled Table XXIII from the records of the Metropolitan Asylums Board, London, for the years 1905-1914.

In closing this chapter one last word of advice is offered to physicians. Consider every sore throat in little children potentially dangerous, never fail to examine them with the greatest care, and if possible see such patients frequently. Hospitalize patients if they cannot be properly cared for at home. Treat them vigorously and promptly, if the diagnosis is diphtheria. Remember that every

day counts, the child is 5 times as likely to die on the second day, 6.8 times on the third day, 7.7 times on the fourth day and 9.2 times on the fifth day as if treated on the first day of the disease. Finally every physician should warn all parents of the possible danger of a neglected sore throat in a young child.

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CHAPTER III

SEPTIC SORE THROAT, VINCENT'S ANGINA, SCARLET FEVER, MEASLES

SEPTIC SORE THROAT

There are other communicable diseases which in certain of their clinical manifestations resemble diphtheria, and one of these at least, is of public health interest, namely, septic sore throat.

Because of its occasional confusion with diphtheria and also because an outbreak of the disease is so often associated with contamination of a milk supply (which might suggest milk-borne diphtheria), this condition will next be considered.

Septic sore throat, or streptococcus sore throat, as it is sometimes called, is usually due to the transmission of the causative agent (a strain of the streptococcus of human origin in milk), and it is a very well-known disease in the United Kingdom. Of recent years it has become prevalent in certain parts of the United States. I am not aware that any definite epidemic outbreaks of the disease have as yet been reported in Canada. Owing to the great severity of the type of cases sometimes observed and the coincident high death rate, it should be considered in any epidemic of sore throats where raw milk (certified or not) is distributed in any community.

The etiologic agent of septic sore throat is always a streptococcus of *human origin* and not a strain of any of the ordinary bovine streptococci, which are almost constantly present in raw milk. Such bovine streptococci are probably harmless. The definite causative relationship of a human strain of streptococcus to this disease has been established, as a result of the work of Theobald Smith and J. H. Brown.

The exact incidence of the disease, even in those communities where it has been observed for many years, is difficult to determine. This is mainly due to the lack of satisfactory morbidity reports. Then, again, it is probable that a number of such cases are diagnosed tonsillitis and their occurrence is not traced, as it properly

should be, to the use of unclean milk, containing the causative germ of the disease. The first epidemic outbreak of septic sore throat carefully investigated, and reported in America, was observed in 1911. Winslow, who investigated this epidemic has since reported the details of other outbreaks. While the initial epidemic occurred in Massachusetts, others have since been observed in Chicago, Baltimore, Concord, N. H., in New York State, in Vermont, and in other places in New England. The disease is notifiable in New York State.

Modes of Transmission

The possible relationship of infected milk to this disease was very early suspected. But until exact studies of sources and modes of infection (epidemiologic investigations) were carried out, the truth was not revealed.

It is now clear, however, as a result of the work of Winslow and his collaborators, that this condition may be transmitted through (a) *milk,* or (b) *direct contact.* Epidemics in which both of these modes of transmission have been the more significant have been reported. At the very beginning of such an outbreak the physician who suspects that he has a patient suffering from septic sore throat (symptoms—reddening of the throat; enlarged tonsils, swollen cervical glands; prostration; high temperature; pseudomembrane—in about 20 per cent of the cases—and other indications of streptococcus invasion) should, of course, take throat swabs, and have them examined *for streptococci as well as for B. diphtheriae.* He should also, in the interest of other members of the family, investigate the source and quality of the milk which they are using. His own investigations (coupled with information which he may obtain from the local health department as to the occurrence of similar cases among other persons obtaining milk from the same source) may enable him to warn the family against the continued use of the milk. Where several cases occur in one household, it is especially likely to have been spread by milk, rather than contact infection.

Furthermore, milk-borne cases of septic sore throat are usually more severe than those transmitted by direct contact.

When the physician discovers a case of this disease, and learns that other cases have been observed in the community for perhaps 4 or 5 weeks, that the cases are widely scattered, and are not all

obtaining milk from the same source (facts which he may ascertain from the health department), he is justified in concluding that the disease is being spread by contact infection. He should take throat swabs from all members of the family. In addition, he should very carefully examine the throats. As has been indicated, septic sore throat is reportable in some communities. If this is not required, certain other steps should be taken by the physician on his own initiative, in the interest of his patient.

The two possible methods of transmission of an epidemic sore throat, not due to diphtheria, should be clearly understood. An explosive outbreak in a community may sometimes be due to one mode of transmission chiefly, but there may be also cases traceable to the other sources of infection. This is confusing—with the appearance of several cases of a disease characterized by an abrupt onset, with diffuse congestion of the throat, profound prostration of the patient, and the other symptoms already noted, the physician is at least justified in regarding the milk supply of his patients, with suspicion.

Methods of Control

Until the milk supply has been found not responsible for the transmission of the germ causing the disease, it should not be used, *unless it is pasteurized.* Some of the most severe outbreaks of septic sore throat described have been due to the use of certified milk (not pasteurized) which has been handled by persons suffering from the disease and contaminated by them. That was the most instructive observation of Winslow, when summarizing the results of his investigations in the United States. In that epidemic, the milk supply (the source of infection) had been under careful sanitary supervision for many years, and for a period of at least twenty-eight years had been distributed and had never been known to be other than a pure, clean source of milk supply. The milk was obtained from tuberculin-tested cows, and frequent laboratory examinations of the milk were made. It was, to sum up, for a great many years, a thoroughly satisfactory certified milk; *but it was not pasteurized.*

It is evident then, that those who use raw milk, even of the grade certified, are exposing the consumers to certain dangers, the potentialities of which may be most serious.

The first essential in controlling this disease is the use of *pasteurized milk only*. Those who live in rural districts and produce their own supply, from cows milked by themselves, are probably the only individuals who are well advised in using milk other than pasteurized.

The second method consists in the complete isolation of each patient and the very careful disinfection, by physical and chemical means, of all discharges from the nose and throat of the patient. The physician should himself carefully avoid becoming infected, or a carrier. He will best succeed by wearing a mask and gown, and by giving careful instructions to have aseptic nursing of the patient strictly enforced. He will, of course, exercise scrupulous care himself to avoid transferring the infection on his hands, or by using a clinical thermometer which has not been disinfected, after being in the mouth of the patient.

The physician should remember that in septic sore throat, just as in measles, scarlet fever, diphtheria and all other communicable diseases of the first group, attention to the details of aseptic nursing by those responsible for the immediate care of the patient, combined with great caution on his part, and strict attention to isolation (if the patient is cared for in the home) are the important links in the chain of adequate control of this type of communicable disease.

VINCENT'S ANGINA

Vincent's angina is a disease which is sometimes confused with diphtheria and is chiefly of importance on that account. It is a condition characterized by a pseudomembranous inflammation of the throat, of a very mild type, with only minor subjective disturbances. Usually the disease occurs in sporadic form. Outbreaks of a minor epidemic sort, however, were reported among troops in certain training camps during the Great War. Its prevalence in the community cannot be determined, because it is not a disease which is required to be reported, although it is communicable. Deaths due to this condition alone, are decidedly rare.

Etiology

The disease is believed to be due to Bacillus fusiformis, a large, coarse, cigar-shaped microorganism, in association with which a

species of mouth spirochaete is constantly found. These two varieties of germs are found also in normal mouths especially about the margins of the gums. They are found in enormous numbers in *direct smears,* made from the pseudomembrane in a case of Vincent's angina. They are also found in abundance, in the mouth, in cases of noma, gangrene of the mouth, ulcerative stomatitis, gingivitis, dental caries and in the mouths of those whose teeth and gums are neglected.

It is probable that in Vincent's angina these organisms, present in the mouth secretions of healthy individuals, assume greater virulence, or, because of some condition of lowered resistance on the part of the individual, they are able to set up the disease process.

Transmission

The condition is transferred by the passage of mouth secretions from one individual to another by droplet infection in coughing, sneezing, etc., or more commonly by mouth secretions of the infected person conveyed to others by use of the common drinking cup, dishes, or by articles shared by individuals, such as towels, etc. Persons who habitually neglect to wash their hands before touching food are, of course, almost sure to transfer this infection (as well as others) if by chance they prepare or serve food while suffering from this disease.

Methods of Control

Patients with Vincent's angina should be instructed to exercise every care to prevent the transmission of their mouth or nose secretions to others. They should be instructed how to keep their mouths and gums free from infection, in the principles of oral hygiene. In the event of an outbreak of the disease in a camp, or an institution, those suffering from the disease should be segregated and made to use separate dishes, etc., which should be sterilized by boiling for five minutes after each meal. They should use separate towels, and their mouth secretions should be carefully disinfected.

This disease is due to anaerobic germs. If, therefore, an individual is suspected, he should have *direct smears* made from the pseudomembranous patches, also cultures to exclude any possibility of diphtheria.

SCARLET FEVER

Scarlet fever was first clearly differentiated clinically by Sydenham. Previous to his work, scarlet fever and measles were considered to be one clinical entity. The disease has for several centuries been very widespread in its distribution throughout the civilized world. Like diphtheria, it is more prevalent in the temperate, than in tropical, zones. A point of great practical importance is that the cases described as scarlet rash, scarlatina, etc., are all actually scarlet fever, and must be dealt with as such. For almost a century it has been known that very mild cases of the disease occur, in which the throat symptoms are the only prominent ones, and no rash is observed. This is of the greatest significance and makes the control of the disease very difficult.

Incidence

In nearly all large communities scarlet fever is endemic and epidemics occur every five or six years. For a number of years the death rate from this disease has been declining. McCollom gives Table XXIV to show the reduction in scarlet fever deaths, in the State of Massachusetts between the years 1866 and 1903.

TABLE XXIV

YEARS	DEATHS	DEATH RATE
1866-1870	4,670	6.8
1871-1875	6,782	8.6
1876-1880	3,517	4.1
1881-1885	2,504	2.7
1886-1890	1,810	1.7
1891-1895	2,857	2.4
1896-1900	1,358	1.0
1901	385	1.3
1902	313	1.1
1903	510	1.7

Crum in the Monthly Bulletin of the Newark, N. J., Department of Health for March, 1920, has summarized the most important features relating to scarlet fever statistics as follows:

"Scarlet fever is more or less prevalent throughout the world, but there are wide variations in its mortality and morbidity rates, racially and geographically. It is less prevalent in tropical and

semitropical climates than in the temperate zones and apparently the negro race is less susceptible to its ravages than the Caucasian race. The scarlet fever death rates are higher in the northern states of the United States than in the southern, and the death rates for the disease in Cuba and Porto Rico in recent years have been very low.

"Surveying 26 countries of the world, the highest rates of mortality are in Hungary, Rumania and Austria; the lowest in Japan, Australia and Uruguay.

"The scarlet fever death rate has shown a downward tendency in the registration area of the United States during the sixteen-year-period, 1900-1915. It is estimated that at the present time approximately 3,500 deaths from scarlet fever occur annually in the Continental United States.

"The improvement of the mortality from scarlet fever has more than kept pace in the United States with that of measles, whooping cough and diphtheria, and at present the actual number of deaths from this cause in the registration area is materially lower than from any one of the other three common communicable diseases of children.

"Season apparently has considerable influence on the morbidity and mortality of scarlet fever. The statistics of New York City when put in the form of a chart show this quite clearly. In the climate of New York scarlet fever reaches its highest point of frequency in March and April, its lowest in July and August. These results doubtless are influenced also by school attendance and close indoor confinement of large aggregates of children during the autumn, winter and early spring seasons.

"In New York City during the five-year period 1912-1916 the scarlet fever case rate per 100,000 total population declined from 251 in 1912 to 104 in 1916 and the death rate from 12.1 in 1912 to 1.7 in 1916. Scarlet fever cases have also become less serious as measured by their fatality percentage which was 4.8 in 1912 and only 1.7 in 1916. This scarlet fever experience of New York speaks volumes for the efficiency of the general health service and school medical service in the city in very recent years.

"Other factors similar, the mortality from scarlet fever is higher in the urban than in the rural areas. The mortality has declined in both areas in the United States during 1900-1915, but the urban

rate (10.0) still averages nearly twice that of the rural areas (5.8), measuring both rates on the basis of 100,000 of the respective populations.

"A detailed study of the comparative mortality rates in 12 large cities of the United States shows that the rates declined during the last 30 years in every city, the range being from 70.4 per cent in

DEATHS FROM SCARLET FEVER—TOTAL NUMBER IN EACH YEAR

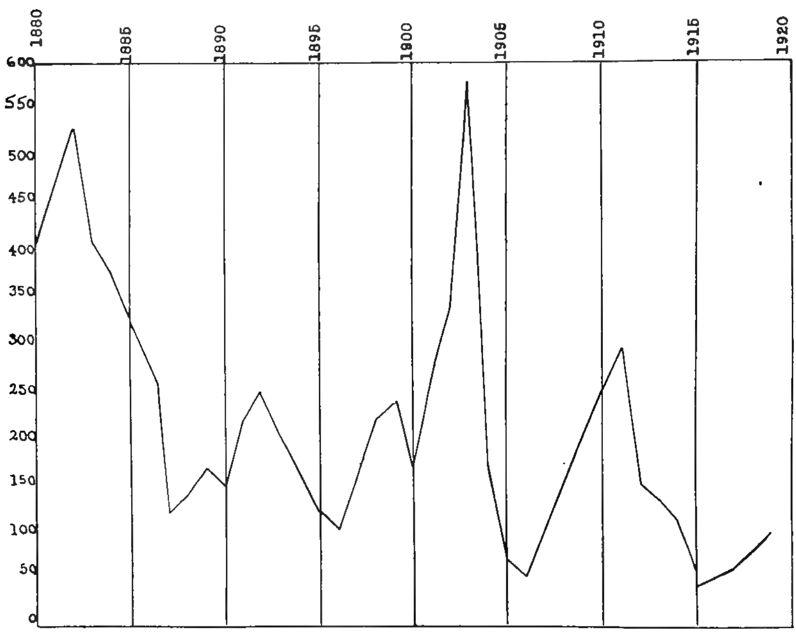

Fig. 1.

St. Louis, to 94.7 per cent in Washington, D. C. The average decline for the 12 cities combined was 79.9 per cent, or from 66.8 per 100,000 total population during 1876-1885 to 13.4 during 1906-1915.

"In ten European countries there has been a notable decline in scarlet fever mortality during the last 30 years, the average being 67.6 per cent and the range being from 31.4 per cent in Austria to 88.2 per cent in England and Wales. In England and Wales the scarlet fever death rate declined from 52.4 per 100,000 of population during 1880-1884 to 6.2 during 1910-1914."

The reduction in the number of deaths from scarlet fever has been very general. The experience in the Province of Ontario is shown in the accompanying tables and graphs.

These diagrams (Figs. 1, 2 and 3) show that scarlet fever is now a much less significant cause of death than a few decades ago.

The prevalence of the disease at present, compared with its incidence in the past, cannot be judged by reference to the mortality statistics alone. Neither is the reported number of cases any real index of the total of those which occur each year. Tables XI and XII give the number of cases reported, through local boards of

DEATHS FROM SCARLET FEVER—PERCENTAGE OF TOTAL DEATHS

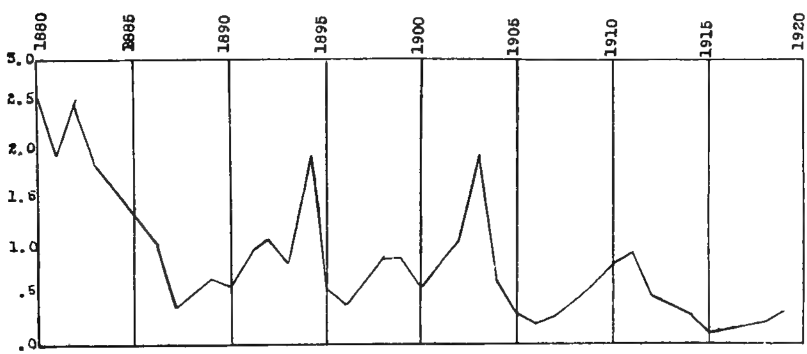

Fig. 2.

health in Ontario, for the years 1918, 1919 and 1920. Unfortunately there are a very considerable number never reported. Some of them are of such a mild character clinically that the physician is never called to see the patient. In others the appearance or rash on a child who does not seem very ill, is the signal for the parents to carefully conceal the fact in order to avoid the possibility of quarantine, etc. Of course, there is also, in the community, a good deal of genuine misunderstanding among the general public in regard to this disease. There are probably many who would call a physician if they realized that a child had scarlet fever, but believing that there are other similar but quite distinct diseases (scarlet rash, scarlatina, etc.) and the child is suffering from one of these, they feel there is no necessity for summoning the doctor. Educa-

tion of the public, by the family physicians, public health nurses, and others is badly needed in this matter. Whatever the incidence of this disease may be, it would be greatly reduced through efforts made possible by prompt notification of cases. The degree of susceptibility to the disease varies according to age. Infants are very susceptible, also young children, and adults are least susceptible of all. The greatest number of cases are usually seen between the ages of three and six years. About 85 per cent of cases are in per-

DEATHS FROM SCARLET FEVER—RATIO PER 100,000 OF POPULATION

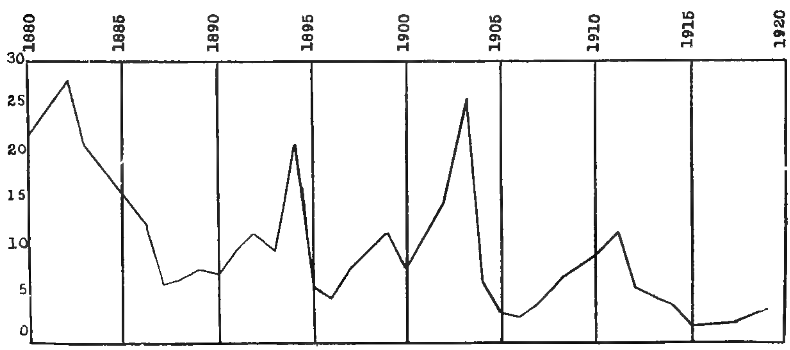

Fig. 3.

sons under 15 years of age. There is no method of determining just who are susceptible to scarlet fever. Diphtheria, unfortunately, is still the only disease where this is possible. We are dependent, then, upon the history of a previous attack of this disease, when considering whether individuals are immune.

Etiology

Much work has been done, with a view to ascertaining the causative agent of scarlet fever, but so far without success. For many years, and by a large number of observations, it was held that a strain of the streptococcus was responsible for the disease. This view is not widely accepted at present. The etiological agent is apparently present in the tonsils, blood, lymphatic glands and on the mucous membrane of the nose, throat and mouth. The incubation period of the disease is from 1 to 8 days, and usually about 2 to 4

days. This has been determined by careful epidemiological observations on large numbers of contacts. Streptococci are probably the cause of secondary infections in scarlet fever.

Modes of Transmission

Scarlet fever may be transmitted *directly* by, (a) patients suffering from the disease in a definitely recognized form or by those who have the disease in such mild form that it is not really diagnosed (the so-called "missed" cases), or by (b) those who are convalescing from an attack but are still harboring the virus, and are capable of transmitting it to others by the transfer of their mouth, nose and throat secretions. Patients during this stage of eruption are most likely to transmit the virus to others. It may be communicated, however, from the time the disease is established, until long after convalescence; that is, until such time as the virus is no longer given off in the nose, throat or mouth secretions. The exact time when the patient is no longer harboring or discharging the virus is very difficult to determine.

The most important factors in the spread of scarlet fever are the "missed" cases, which, of course, are not reported, and the cases which, while possibly recognized, are concealed in order that quarantine may be avoided. The disease is probably only occasionally transmitted *indirectly* by fomites, etc.

Quite frequently scarlet fever is conveyed through the medium of milk, contaminated with the virus of the disease. More than 50 milk-borne epidemics of scarlet fever have been reported.

Control

One attack of the disease usually confers a permanent immunity, although in certain instances second attacks are known to have occurred. A history then of a previous attack of the disease is useful information, because it may simplify the difficulties in the way of preventing the further spread of the disease.

The patient should be isolated, other members of the family carefully examined, and their histories with reference to any previous attacks of communicable diseases, elicited. Throat swabs should be taken if there is any suspicion of diphtheria, as, for example, in the case of mixed infection, (scarlet fever and diphtheria). The

case should be reported immediately to the health department and quarantine will be established. The house in which the patient is, will be placarded. Careful instruction should be given by the physician at the first visit, that no one other than a physician, nurse, attendant, or spiritual advisor should visit the patient.

Those whose duty it is to come into association with the patient should wear a gown and a gauze mask. Receptacles containing disinfectants should at once be provided for the reception of mouth and nose secretions. Aseptic nursing technic should be applied, and every care exercised to prevent the further spread of the disease, just as is recommended in diphtheria.

We are greatly handicapped in our efforts to control scarlet fever because (a) we do not know the cause of the disease; (b) there is no laboratory method of value to help the physician in diagnosis; and (c) because we have no specific method of control. The use of both vaccines and sera, in the control and treatment of the disease have been tried, without any measure of success.

Gauze wipes contaminated by mouth and nose secretions should be boiled for half an hour or burned. Bed and body linen should be boiled or steam sterilized. Special dishes should be used by the patient, and these sterilized, by boiling after use. Clothing, etc., worn by the patient, before the illness, should be disinfected. Cleansing of the room, etc., should be carried out at the termination of the illness.

Thorough and careful supervision of the milk supply and its pasteurization will control milk-borne scarlet fever. Efficient medical and nursing work in the schools, and careful follow-up work in the homes of *patients, contacts, suspects, etc.*, by public health nurses, should do much in helping cases to be recognized early and isolated. Think of the possibility of scarlet fever *when* it is especially prevalent and a child is reported by the parents to be suffering from sore throat. Examine such a child carefully for any sign of a rash. Look at the skin between the fingers and toes particularly, where there may possibly be found some evidence of desquamation. The blandishments of those who wish to have the case concealed should, of course, be resisted.

Difficulty sometimes arises when the questions of raising the quarantine, and release from isolation, are to be settled. If the patient has completely recovered, and if desquamation is absolutely com-

plete, there is still a question of whether the person is harboring the virus in the mucus membranes of the nose, throat, mouth, etc., or giving it off in the occasional discharges from the ears. It is impossible to be too careful in deciding this question. Observation of the patient for many days will be necessary. Even then "return" or secondary cases will occur. That is, cases will arise among other members of the family, when one patient has recovered from the disease and is permitted to return from the hospital. The physician may safeguard himself by obtaining advice from a member of his local health department in matters of this sort. In many communities he will be provided gratuitously with such assistance, and in addition very definite quarantine regulations are laid down (which differ slightly in different communities), but with which every physician should be entirely familiar.

Scarlet fever is a serious disease because of its sequelae. Nephritis, otitis media, adenitis, arthritis, etc., may cause much disability and suffering and are directly chargeable to antecedent scarlet fever. Therefore it is a duty which physicians owe to their patients to call attention to the gravity of any of the conditions which may result from a previous attack of this disease, especially if proper care and treatment is not provided. The occurrence of a case of scarlet fever or of any communicable disease in an individual or member of a family engaged in the handling of milk, or in the preparation or serving of any food, is a very serious matter. The responsibility for action under such circumstances should be immediately transferred to the local health department.

Hospitalization of cases of scarlet fever, under unfavorable social conditions (in large families living in two or three rooms, or where adequate nursing care cannot be provided) is just as necessary and desirable as it is in diphtheria, and the result obtained will be equally satisfactory.

MEASLES

Measles is one of the most universally prevalent of the acute communicable diseases. It occurs everywhere throughout the world. It is usually present in endemic form, but epidemics especially in temperate climates are observed two or three years in a more or less regular cyclic fashion. It would appear that measles becomes epi-

demic when a large number of susceptible children are found in a community. The epidemic occurs, burns itself out, and returns, with the arrival in the same community of large numbers of children born after the occurrence of the previous epidemic. As a cause of

DEATHS FROM MEASLES—NUMBER OF DEATHS IN EACH YEAR

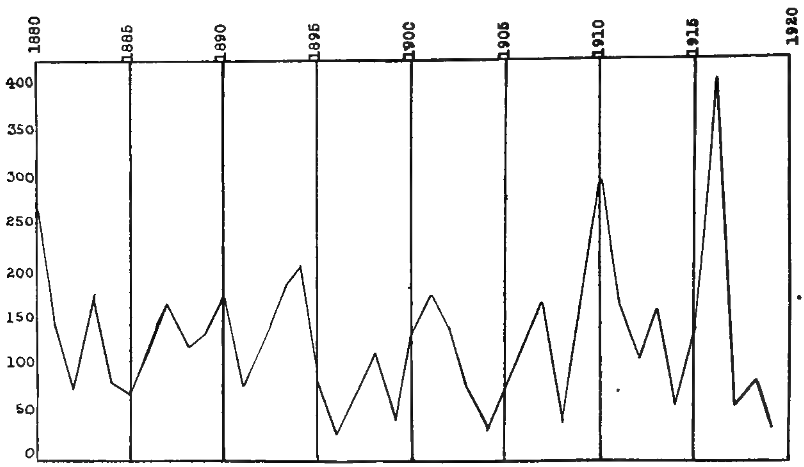

Fig. 4.

DEATHS FROM MEASLES—PERCENTAGE OF TOTAL DEATHS

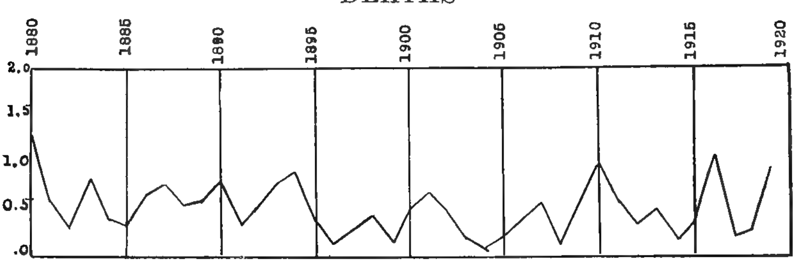

Fig. 5.

death it is especially significant during epidemic years. Its importance in relation to other causes of death in the Province of Ontario for the past 38 years—1880 to 1918—is shown in Figs. 4, 5, and 6.

The number of cases reported for 1918, 1919, and 1920 in Ontario,

is indicated in Tables XII and XIII. These, of course, give a very imperfect idea of the actual prevalence of the disease because of incomplete notification of cases. The fact that measles is a very common communicable disease is thoroughly appreciated; the significance of measles and its sequelae as causes of death, and disability in children under two years of age is, however, not nearly so well understood as it should be. For the year 1910, in the registration area of the United States, measles ranked next to diphtheria among the acute communicable diseases of childhood, as a cause of death. The disease does not occur among lower animals. In man there is hardly any natural immunity to it. For a very long time

DEATHS FROM MEASLES—RATIO PER 100,000 OF POPULATION

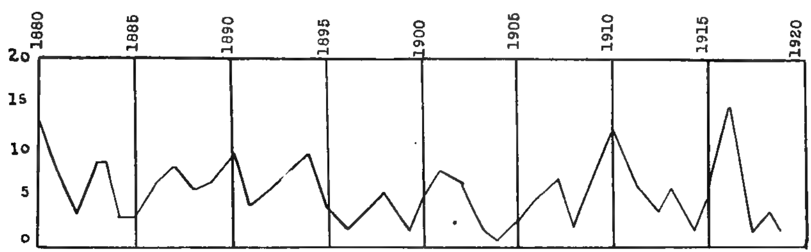

Fig. 6.

it has been looked upon as the type of a so-called "contagious" disease. The extreme communicability of measles is due to the relative rarity of any natural immunity combined with the fact that it is really transmissible during the preeruptive stage. The seasonal incidence is similar to that of diphtheria and scarlet fever. It is much more prevalent during the cold weather, and the school months of the year. As Brownlee has pointed out, the cases among children of pre-school age result from the transfer of the virus of the disease, from children, in the family, who are attending school. There is a degree of insusceptibility among infants until they reach the age of six months. From that period onwards, nearly every individual is susceptible. It is stated that the greater prevalence of the disease among children accounts for its rarity among adults, who probably acquire immunity as a result of an attack of the disease in earlier life. McCollum gives several references to cases of children being

born with the disease. This is so-called antenatal measles. One attack of the disease usually confers lasting immunity. Second attacks are very uncommon. Where such are reported the accuracy of the diagnosis may be questioned.

Etiology

The cause of measles is not known. It appears to be due to a virus which is believed by many to be present in the circulating blood, and in the nasopharyngeal secretions for at least 24 hours before, as well as for a day or two after, the rash appears (Hektoen). Measles originates apparently as an infection of the conjunctival and respiratory mucous membranes. It does not set up secondary or metastatic infections in the viscera. It does, however, predispose to infection with the microorganisms of certain diseases, notably tuberculosis, and bronchopneumonia. The virus seems to be able to stimulate the production of protective substances because an attack of the disease gives rise to a pronounced immunity. It is claimed by Hektoen that monkeys as well as man, are susceptible to measles. When the disease is artificially transmitted to monkeys, there is usually an incubation period of about eight or nine days, after which there is a mild febrile reaction; a maculopapular rash; respiratory symptoms; Koplik spots, and the leukopenia which is characteristic of measles.

During the early part of the eruptive stage the virus is present in the nasal secretions, scrapings from the skin (containing blood) and in the circulating blood.

Modes of Transmission

In measles the virus is, as a rule, transmitted *directly* from the individual with measles; to susceptible contacts, and only *very uncommonly indirectly*, by well persons (passive carriers, physicians, nurses, etc.) harboring the virus, or by fomites. Measles is transmissible during the unrecognized, preeruptive period, and this, more than any other single factor, renders the control of measles extremely difficult.

It is not determined with absolute certainty just how soon after infection the disease can be transmitted. It seems probable, however, that in very few children is the incubation period less than

seven days. The average incubation time is probably ten to fourteen days. The significance of this fact is that during the first seven days' exposure to infection the susceptible child in whom the disease may be developing, cannot transmit it to others, and is not a menace in the home or in the community. The danger period, in so far as the transmission of the disease to others is concerned, is between the seventh and fourteenth days after exposure to infection. Almost all observers are agreed that with the appearance of the first symptoms of the disease (not the rash), the patient is in a condition to transmit the infection. It is thus evident that the nature of these first symptoms is of very great significance, in the control of the disease. The first and *most important symptom is a rise of temperature.* The physician, therefore, (especially in the case of little children) in dealing with his measles contacts, should take the temperature morning and evening, particularly on the eighth, ninth and tenth days after exposure. It is wise even to continue to have the temperature taken until the fourteenth day, in the case of children of pre-school age for whom measles or its sequelae may be a most serious matter. The second symptom is *edema of the conjunctiva.* As indicated by Brownlee, this is the earliest catarrhal symptom to appear. The edema is especially marked in, and practically confined to, the palpebral conjunctiva particularly of the lower lid. The damage has been done if the physician waits for the appearance of Koplik's spots.

Methods of Control

If these two symptoms can be detected before the appearance of any others, the physician may succeed in preventing the spread of the disease to other children, by absolutely isolating the patient, immediately reporting the case to the local health department (through which, arrangements for placarding the house will be made), and instructing those who are to care for the child, the important application of the principles of aseptic nursing. The greatest possible vigilance should be exercised to prevent the dissemination of nasal or pharyngeal secretions of the patient by any one coming in contact with the sick child. Articles containing these secretions should be burned, or disinfected by chemicals, or by boiling. Care of personal linen is also essential during the first five days of the disease. Separate dishes should be provided and their

sterilization insisted upon. A gown should be worn when visiting patients, and the hands and face washed after any examination.

Measles is frequently not controlled because of the lack of concerted effort. The present attitude is too often one of *laissez-faire.* The physician must have a clear mental picture of the disease and its periods, as far as infectivity is concerned. First, incubation period, patient noninfective, this is practically never less than seven or eight days—then two or three days during which characteristic first symptoms may manifest themselves. Second, tenth to fourteenth day, the preeruptive period; when the patient is especially liable to transmit the disease to others. Third, the rash appears, and the patient is still able, for from one to five days to transmit the disease, and finally the noninfective period. To sum up, five days before the rash appears, and for five days thereafter, the danger of transmission is greatest.

With the physician and public health nurse in possession of this knowledge, and fully aware of its importance, the next step is for them to communicate it to parents, and especially to mothers. Public health nurses can be of the greatest possible assistance in spreading broadcast this most important information and in assisting in the early detection of cases. A potent method of arousing the interest of mothers, is to point out that in infants and young children under two years of age, especially, the danger of the child contracting bronchopneumonia (usually a pneumococcus or streptococcus infection) at once, and dying therefrom, is very great. Or, the child may develop middle ear disease and suffer from a pronounced and permanent deafness thereafter. Or, tuberculous infection may supervene and an early death or a pronounced degree of disability ensue. A knowledge of these facts may make a real impression, whereas the fear of measles infection, as such, may be negligible.

Brownlee in his excellent summary of the administrative control of measles offers the following concrete suggestions in regard to prophylaxis and treatment:

"If young children have been exposed to measles what procedure is necessary? I think it is essential that they be put to bed before the first symptoms appear—that is, eight days after exposure to infection—and kept there for a few days until it is certain whether the infection has been acquired or not. There is all the difference in the world between an attack of measles developing in a child

exposed to body chill owing to draughts, etc., and a child developing the diseases under conditions of warmth and rest. Even if this stage be missed, with the first symptoms of catarrh, bed is the place.

"In the next place, if the disease promises to be of great severity, I am quite certain that hospital treatment is the best. When, on the fourth or fifth day of illness, the râles begin to appear in the bronchi, great respiratory distress and cyanosis are frequent. This condition I call 'suffocative catarrh' to distinguish it from bronchopneumonia. It is one of the curses of the cellular pathology to group all sorts of different diseases under one name. This suffocative catarrh is part of the disease—measles—and has no relation to the true bronchopneumonia, which is quite a different disease. The catarrh kills in a few days, the bulk of the deaths occurring within eight days of the first symptoms of measles. Bronchopneumonia runs a longer course, the bulk of the deaths occurring twelve days after the onset of the disease. It is a secondary infection to measles, while the catarrh is part of the primary disease.

"This catarrh, if severe, is a condition of extreme gravity, which demands careful nursing and also environmental conditions not easily obtained in a private house. I have not a particle of doubt that these children are very much better treated in the open air. Furthermore, the administration of oxygen in many cases makes all the difference between recovery and death. In addition, though the remark is not strictly appropriate in this connection, these children, in my experience, are better for a certain amount of alcohol if they are not too cyanosed to oxidize it. In making these statements I am fully aware that I am speaking somewhat rashly, because, regarding children suffering from suffocative catarrh in measles I have never learned to make anything which can be called an accurate prognosis, and consequently have difficulty in stating the results of treatment statistically. Thus, in teaching I have demonstrated 2 cases to my students—one as likely to recover, and the other as likely to die—only to have to point out the next day that the child I thought was probably going to recover was now dead, and that the other, if not out of danger, was at least considerably better than on the previous day. This rapid improvement is the rule in cases of suffocative catarrh if cure is to take place. A child may be within the immediate zone of death and within a couple of days be comparatively well. If bronchopneumonia is implanted on the catarrh,

the change to convalescence is a matter of ten days to three weeks. The two conditions should not be confounded.

"A further point of importance with regard to the treatment of severe cases of measles, and a treatment only easily obtained in hospitals, is the care of the eye. An attack of measles is quite frequently the starting-point of eye trouble. For the proper cleansing of the eye regular washing out is necessary, and the technique requires adequate training on the part of the attendants. Sometimes even hourly cleansing is required, and that cannot be provided at home except in the houses of the rich."

These suggestions if faithfully carried out will yield much in the way of a satisfactory reduction in the number of deaths and volume of disability directly chargeable to measles.

In addition, of course, the physician must comply strictly with the public health laws and regulations of his own community, with which he is expected to be familiar.

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CHAPTER IV

GERMAN MEASLES (RUBEOLA), MUMPS, WHOOPING COUGH

GERMAN MEASLES: (RUBEOLA)

German measles is a minor communicable disease of childhood, and chiefly significant because of its occasional confusion with scarlet fever and measles.

Etiology

The causative agent of German measles is unknown. It is believed that the virus is discharged from the body, in the mouth and nose secretions.

Incidence

No figures are available as to the prevalence of the disease. It occurs in all communities in endemic form, but occasionally widespread epidemics occur. Both adults and children are susceptible to the disease. The fact that antecedent attacks of measles or scarlet fever afford no protection against German measles is significant, and is an important fact in establishing the diagnosis in doubtful cases.

Modes of Transmission

The disease is spread *directly*, through contact with the patient, or indirectly by fomites (towels, handkerchiefs, etc.) wet with the nose and mouth secretions of the patient.

The incubation period of German measles is from ten to twenty-one days.

This disease is believed to be readily transmissible during the first eight days, after the appearance of symptoms. How long the patient remains in a condition in which the virus can be transmitted is not definitely known. With the subsidence of fever and at the end of desquamation, infectivity probably disappears also. The differential diagnostic features are absence of severe prodromal

catarrh, of Koplik's spots, and the presence of a light rose-red, macular, rarely confluent rash, beginning on the face and scalp, and extending in crops over the rest of the body, in about 24 hours. These all help to distinguish German measles from measles.

Methods of Control

Despite our limitations in the knowledge of German measles, it is highly desirable that efforts be made to prevent the spread of the disease, by strict isolation of the patient, and the destruction of mouth and nose secretions. In addition, if there is any doubt as to diagnosis, the assistance of a representative of the health department should be requisitioned to aid in establishing the nature of the condition. This is of much importance if, by chance, the case turns out to be measles or scarlet fever. Much good would be accomplished if all such cases were reported, and very careful and complete general measures at once instituted, as outlined in measles, diphtheria, and scarlet fever, to prevent the further spread of the disease.

MUMPS

Mumps, like German measles, may be designated one of the minor, acute, communicable, or transmissible diseases.

Etiology

The microorganism responsible for the production of mumps is as yet unknown. Several observers have, by the injection of secretions of the parotid glands (obtained from cases of mumps), produced, in animals, changes in the parotid glands similar to those found in mumps.

Incidence

.This disease is endemic in all large centers of population, especially in temperate climates. Epidemic outbreaks of the disease are especially common in institutions, such as boarding schools, etc. Mumps is more prevalent in childhood than in adult life. In many communities it is not required that cases of the disease be reported, so its exact prevalence, communicability, etc., cannot at present be determined.

Modes of Transmission

The most characteristic symptom of the disease, inflammation of the parotid glands (with occasionally secondary inflammation of testes, or ovaries or breasts in females) suggests that in all probability the causative agent is conveyed by direct contact through transfer of mouth secretions, from the patient to susceptible individuals who have been in intimate association. Towels, body linen or any article used in common, if moist with such mouth secretions would, of course, also convey the infection indirectly. It is probably only rarely, if ever, conveyed by a third person. The incubation period is from four to twenty-five days. The disease is said to be communicable before the symptoms have appeared, that is, during the incubation period, and for even six weeks after the symptoms have subsided. These facts account for the difficulty in controlling the disease, in outbreaks occurring in institutions.

Methods of Control

The patient should at once be isolated and the health department notified. Early recognition of the disease is very important, and inflammation of the duct of Steno may be noticed before distinct swelling of the glands is manifest, and is of assistance in this particular. Concurrent disinfection and aseptic nursing are indicated. And, as in diphtheria, scarlet fever, measles, German measles, etc., if this is thoroughly carried out, terminal disinfection will be a very simple matter. In schools, etc., these cases should all be treated in infirmaries, where the facilities of an isolation hospital are provided, and this, of course, simplifies control. Observation of contacts and early diagnosis of fresh cases are the points of importance in checking an outbreak.

WHOOPING COUGH

It is only very recently that whooping cough, even among those engaged in public health work, has received the recognition and attention it deserves as one of the important and serious communicable diseases of early childhood. It is significant because of the number of deaths for which it is responsible, and of the fact that it prepares the soil for the reception of the tubercle bacillus. Exclud-

ing tuberculosis and pneumonia, probably none of the communicable diseases of childhood exacts a heavier toll of young lives. Many of them, unfortunately lost quite unnecessarily. The traffic in human saliva, of which Chapin writes, in large part provides the explanation of the persistence of whooping cough.

Incidence

The disease is very widespread and usually endemic in all temperate climates. Serious epidemics occur, and these vary considerably in their attack rates (proportion of individuals in a community, presumably exposed to infection, who develop the disease)

DEATHS FROM WHOOPING COUGH—PERCENTAGE OF TOTAL DEATHS

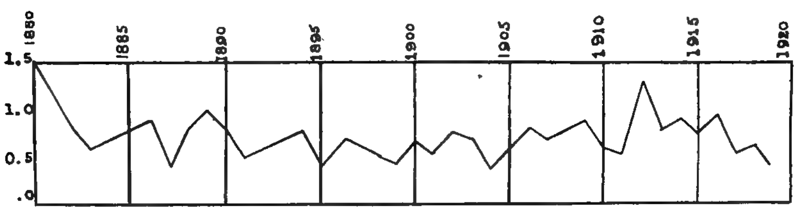

Fig. 7.

DEATHS FROM WHOOPING COUGH—RATES PER 100,000 OF POPULATION

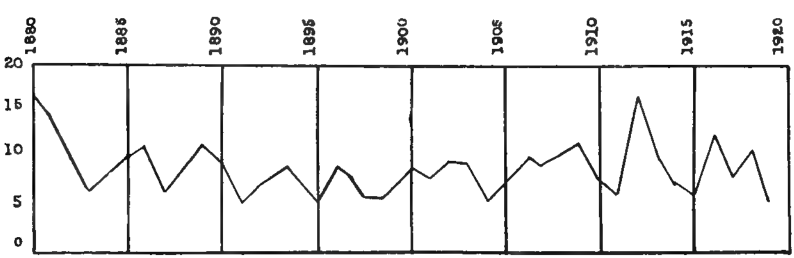

Fig. 8.

and case-fatality rates. Whooping cough is usually more prevalent in cold weather. However, epidemics may occur at any season of the year. In 1917, in England, 4,509 deaths from whooping cough were registered; and, excluding tuberculosis, it was third on the list of causes of death from communicable diseases. In the regis-

tration area of the United States in 1919, whooping cough caused 4,714 deaths; this was a rate of 5.5 per 100,000 of population and .5 per cent of the total deaths.

The Ontario mortality is shown in Figs. 7, 8, and 9.

The number of cases reported in Ontario during 1920, as shown in Table XIII, gives an inadequate idea of the prevalence of the disease, since in many cases there is no notification.

DEATHS FROM WHOOPING COUGH—NUMBER OF DEATHS

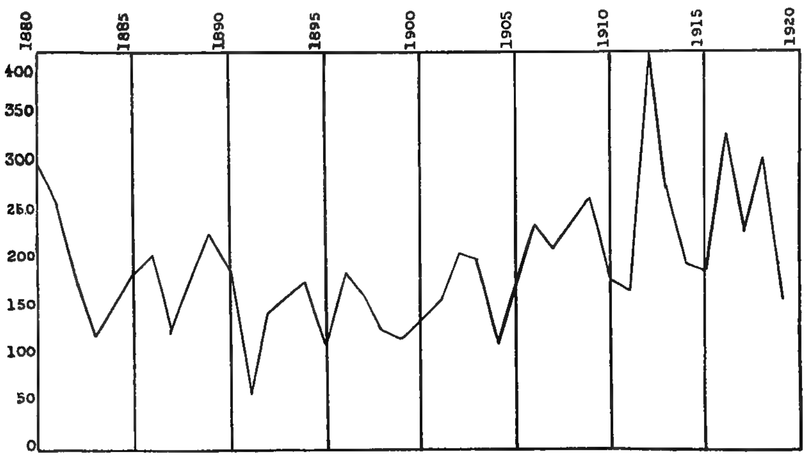

Fig. 9.

Furthermore, a mere statement of the number of deaths from whooping cough does not adequately represent the total damage done by this disease in the community. No accurate estimate of the subsequent cases of tuberculosis which develop as a result of diminished resistance incident to whooping cough, can be obtained.

Etiology

Whooping cough is caused by a fine, hemophilic, gram-negative bacillus, the so-called *B. pertussis* described by Bordet and Gengou. The germ is found in the secretions brought up from the bronchi during paroxysms of coughing. It is very difficult to demonstrate the presence of the causative agent, except during the early stages of the disease. Man alone is susceptible to infection, under natural conditions, but apes, monkeys, puppies and cats can be artificially

infected under certain circumstances. The isolation, in culture, of B. pertussis in cases of whooping cough can, as a rule, be successfully accomplished only by well-trained bacteriologists and under favorable conditions.

Modes of Transmission

While whooping cough is usually transmitted by direct contact, through droplet infection, to susceptible individuals from a patient suffering from the disease, it is also transmitted by carriers, and indirectly by fomites (objects on which mouth and nose secretions are conveyed to others). Handkerchiefs, towels, toys, candy, pencils, etc., used in common by young children readily provide a means of transferring the germ from one child to another. The disease has an incubation period as a rule of two to fourteen days. Whooping cough is not communicable during the period of incubation. It is especially communicable during the early period of the disease and before the appearance of the characteristic whoop. While it is probable that the disease is acquired only occasionally from patients who have passed the early catarrhal stage, it is known that some patients transmit the disease for longer periods. Two weeks after the first appearance of the whoop marks the close of the period of greatest communicability in the average patient. This corresponds with the time, after which B. pertussis can rarely be grown from sputum. Practically everyone is susceptible to whooping cough, but the period of greatest susceptibility is between six months and five years. Infants under six months are probably immune in the majority of cases, on account of the immunity acquired from the mother. After five years of age susceptibility is decidedly diminished. One attack confers a fairly durable immunity and second attacks are uncommon. The fact that carriers of whooping cough may harbor and transmit the germ of the disease for long periods of time is important. Outbreaks of whooping cough are known to have been initiated by carriers.

Control

Whooping cough, like measles, is extremely difficult to control because of:

(a) A period of varying length, comparable to the pre-eruptive

period in measles, during which the characteristic symptom of whooping is absent.

(b) Because of mild cases of the disease which are missed—and,

(c) Because of carriers, whose presence is not suspected.

The first and most essential point is *early diagnosis.* When the disease is prevalent in a community, if the physician is called to see a child with what may be described as a heavy, or severe bronchial cough, the child should at once be isolated, and not allowed to come in contact with any other children until the cough has subsided. A leucocyte and differential leucocyte count should be made after the first clinical examination. A high leucocyte count is an early feature of the disease. An average count of more than 20,000 leucocytes per c.mm. during the early catarrhal stage is usually observed. The lymphocytes are either absolutely, or relatively increased, and this is the significant point. Competent bacteriologic examination of fresh bronchial (not mouth), secretions, especially very early in the disease may help in diagnosis. These points, taken in conjunction with a history of possible exposure to many cases of the disease prevalent at the time, should arouse suspicion. The arrival of the whooping stage, or a history of vomiting after a paroxysm of coughing, renders the diagnosis, as a rule, not difficult. Many new cases, however, have probably been infected by that time. After the diagnosis is made immediate isolation, notification, careful attention to aseptic nursing, with concurrent disinfection of mouth and nose secretions, should be carried out in every case. Exclusion from school, etc., of contacts is very wisely insisted upon during the incubation period.

The present general indifference of many parents to the potential dangers of whooping cough renders prevention difficult. Educational efforts carried on especially by public health nurses, in the homes, in instructing mothers as to the dangers of mouth and nose secretions from children with the disease, should in time, be of value.

Whooping cough clinics are carried on in some communities. If they are situated in health centers within easy reach of those for whom they are established, they undoubtedly do good. But taking children long distances on street cars while suffering from the disease is most reprehensible.

In the case of children of pre-school age, who are contacts, the

physician may recommend to the parents a course of action similar to that advised in measles, especially, if the children have colds. Have them put to bed and keep them there, until after the period of incubation has passed. This recommendation has merit because, if followed, the incidence of the disease and the sequelae would be much less common than at present.

Physicians owe a duty to parents, and to the community, to emphasize the importance of isolation and other measures proposed, and to continually reiterate the potential dangers of whooping cough. Terminal disinfection by cleansing with hot water and soap, and then thorough airing, should be carried out.

Specific Prophylaxis

For some time past a bacterial vaccine made from several strains of B. pertussis has been used by many physicians for the prevention of whooping cough. Opinions differ greatly as to its value. It should be remembered that from 10 to 21 days will elapse after the series of injections of the vaccine, before an immunity supervenes. Therefore, vaccination to be effective must be carried out very promptly and early in an outbreak, where children are known to have been exposed to infection.

In addition to efforts to secure a specific immunity, the vaccine has been recommended for use in the treatment of the disease. It is probably less valuable at present than good nursing care, adequate nourishment, and efforts put forth to prevent the development of serious sequelae.

The dosage of vaccine, and the question of whether it is freshly prepared from suitable antigenic strains of B. pertussis are said to determine in large part its prophylactic or therapeutic efficiency.

Far more important than anything else is a measure which will bring home to those responsible for the welfare of little children, that 95 per cent of the deaths from whooping cough, in one year in the United States were *in children under five years of age,* and this largely, because they were not protected from infection.

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CHAPTER V

TUBERCULOSIS, PNEUMONIA, INFLUENZA, BRONCHO-PNEUMONIA, COMMON COLDS

TUBERCULOSIS

Tuberculosis is a chronic communicable or transmissible disease to which man and many species of lower animals are susceptible. This disease is one of the greatest scourges of the human race at the present time, and is very frequently designated the White Plague. It is generally agreed that practically every one living in civilized communities is, as a result of universal exposure to tuberculosis, at some time infected with the germ of the disease. Or, as Sir George Newman has expressed it, "Latent tuberculous infection is so widespread as to be almost universal."

Incidence

While latent infection is almost universal, the actual prevalence of tuberculosis in any community is rather difficult to determine. Various investigations undertaken in different communities have revealed the fact that from 50 to 90 per cent of children under 15 years of age give a positive intracutaneous tuberculin test. Other evidence is available, however, which indicates that only a small percentage of all individuals develop tuberculosis. In other words, in the majority of adults the infection remains latent.

In a very interesting report recently (December, 1920) issued by the Board of Consultants of the Department of Soldiers Civil Re-establishment, Canada, this question is considered more or less in detail. While this report is concerned primarily with the question of tuberculosis among ex-service men of the Canadian Expeditionary Force, reference is also made to the estimated incidence of the disease in the civilian population. To quote from this report: "The 8,571 so-called tuberculosis ex-service men treated by the Department to April 20, 1920, when proportioned to the 590,572 men entered in the Canadian Expeditionary Force give an incidence

rate of 2.4 per 1,000, yearly, for 5¾ years considered. This will be referred to as the crude *incidence rate.*

"The average number of men under arms throughout the period of the war, with deductions for dead and missing, has been estimated at 317,000. The annual incidence rate is more fairly based upon this number, and is 4.7 per 1,000. Since 8.6 per cent of the patients treated in sanatoria were diagnosed as nontuberculous, .4 per 1,000 should be deducted, leaving 4.3 per 1,000 as tuberculous. These are further divided into bacillary positive cases, 1.9 per 1,000 (44 per cent), and clinically tuberculous cases 2.4 per 1,000. This rate of 4.3 will be referred to as the corrected incidence rate.

"**Comparison with B. E. F.**—The incidence rate of tuberculosis in the British Forces, obtained by proportioning the total cases, to total enlistments, without correction for the annual average under arms, is 1.07 per 1,000 yearly. It is understood that, in Great Britain, the presence of bacilli was necessary for a diagnosis of tuberculosis; so that, instead of comparing the rate of 2.5 per 1,000 similarly obtained for the C. E. F., with the British rate, the crude rate of bacillary positive cases only should be used, 1.1 per 1,000 (44 per cent of the 2.5 crude rate). The incidence rate is, therefore, approximately the same in the two armies; but, in Canada, 1.4 per 1,000 have been treated in addition as being probably tuberculous.

"**Comparison with A. E. F.**—The rejections for tuberculosis from the first million men drafted into the American army, were 8.73 per 1,000—more than 6 times the death rate estimated for men of military age in Canada. This was quite a nonselective draft, and many cases of active tuberculosis were necessarily included. The breakdown rate during service (incidence) was 2.9 per 1,000, rather more than the comparable incidence (2.5) of the C. E. F.

"**Comparison with Civil Life.**—A comparison between the incidence of tuberculosis in the army and in civil life, while of interest and importance, may only be approximated. Too short a time has elapsed for the death rate from tuberculosis in the army, to become reliable for comparison with the civilian death rate. The civilian death rate is the only index of the amount of tuberculous disease in the community at large; and, by multiplying this by various factors, estimates have been made of the morbidity, or tuberculous

status of the community, existing at any one time. It is fallacious, however, to compare this momentary status with the annual incidence, or crop of tuberculosis, yielded by the army, removed from it, and placed in sanatoria. The civilian incidence is that amount of new tuberculosis which yearly enters the tuberculous group to replace losses by death and recovery, absolute or relative. The

DEATHS FROM TUBERCULOSIS—TOTAL DEATHS

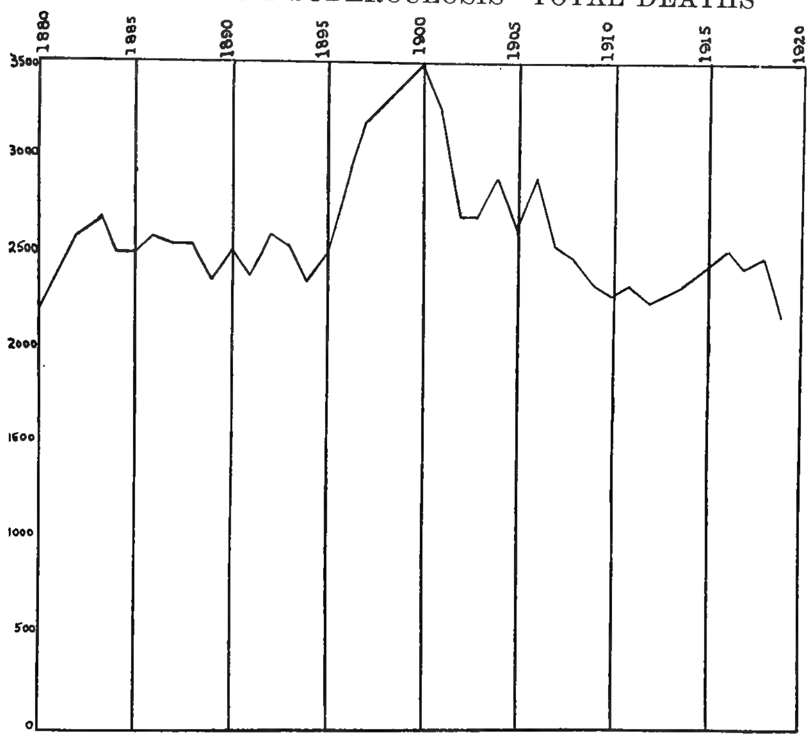

Fig. 10.

civilian incidence, with some variation, has long been operating to involve the tuberculous group.''

It can be shown, according to Parfitt, ''that, operating for a period of 20 years, an annual incidence of one and a third times the death rate will compensate losses by death; maintain an average number of 10 times the death rate, of clinically active cases; a group of equal size of less obviously active and arrested cases. Two-thirds

of this group of arrested cases (16 per cent of the incidence) will not die from tuberculosis within the period. This last group is fairly comparable with the 25 per cent of patients who do not die from tuberculosis within 20 years after discharge from the Trudeau Sanatorium.

"In Canada, the death rate from tuberculosis in 1915, was 1.08 per 1,000 for the whole population. For men of military age, the rate has been estimated at 1.36 per 1,000 for the whole country, from incomplete vital statistics. This group had a rate of 1.06 per 1,000 in the Provinces of Alberta, Saskatchewan, Manitoba and Ontario. The general rate of these 4 Provinces was .84. This relatively more vigorous population provided 66 per cent of the enlistments.

"The development of tuberculosis will continue, somewhat modified, because of selection, in the army group, apart from all considerations of army life. The army has the advantage of the selection of an average higher physical manhood than the average of civilian life, while the men composing it had the advantage of regularity of life; much time spent in the open air; and a higher standard of food. On the other hand, the men have undergone varied hardships of service, and have been exposed to intercurrent diseases through close association in barracks, etc., to a greater extent than the civilians. Any difference between the natural civilian incidence for men of military age, and the actual incidence in the army group will be due to army life. An incidence rate somewhere between one and one-third times and twice the death rate (1.36 of males of military age) may reasonably be assumed to be operating in any case, as amongst civilians. This will be from 1.8 to 2.7 per 1,000. The correct army incidence was shown to be 4.3 per 1,000. An additional incidence rate somewhere between 2.5 and 1.6 per 1,000 may, therefore, fairly be considered due to army life. This is an increase over the estimated rate of incidence for civilians of 140 per cent in the first instance, and 60 per cent in the second. Broadly speaking, there is, then twice as much tuberculosis amongst the civilians of the same age period, (20-44)."

Armstrong has shown in the Framingham Demonstration that among several thousand persons examined in homes, schools, factories and elsewhere, 0.95 per cent were active cases of tuberculosis and 2.15 per cent active and arrested cases combined. Also it was

found that 9 or 10 active cases were discovered for every annual death.

In 1919 in the registration area of the United States there were,

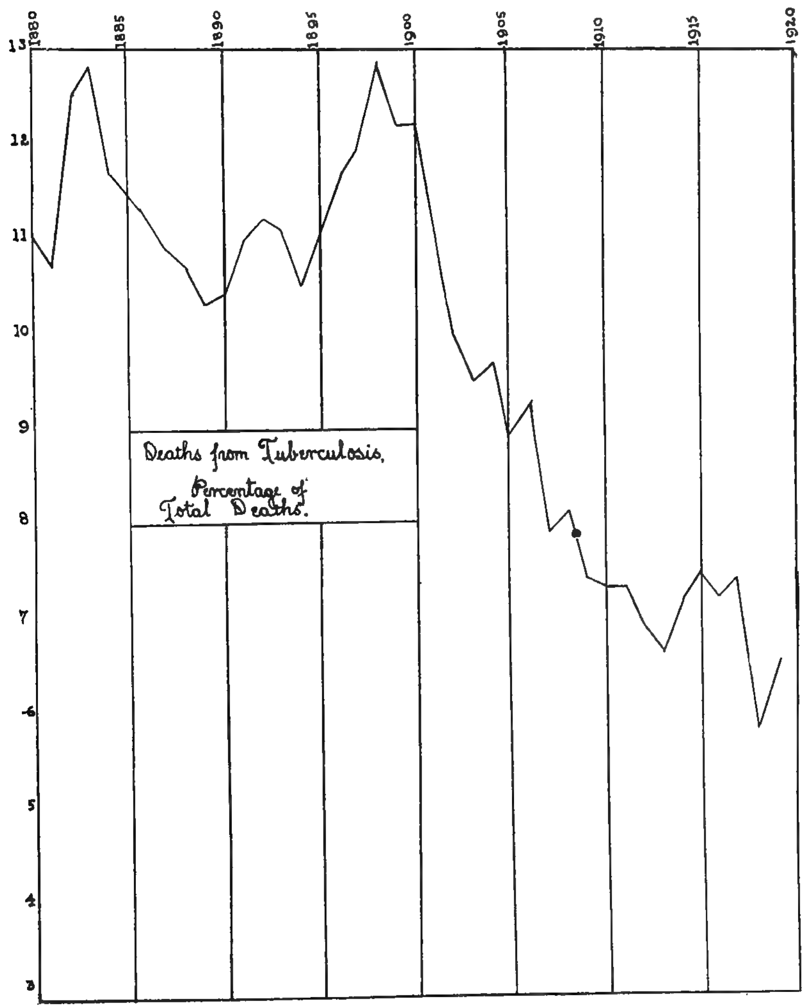

Fig. 11.

as shown in Table III, 106,985 deaths from tuberculosis (all forms), and 94,772 deaths from pulmonary tuberculosis. The ratio per 100,000 of population and the percentage of total deaths due to

tuberculosis in the same year, is also shown in that table. In the same year (1919) there were in the Dominion of Canada between 9,500 and 10,000 deaths from tuberculosis. On the basis of Parfitt's

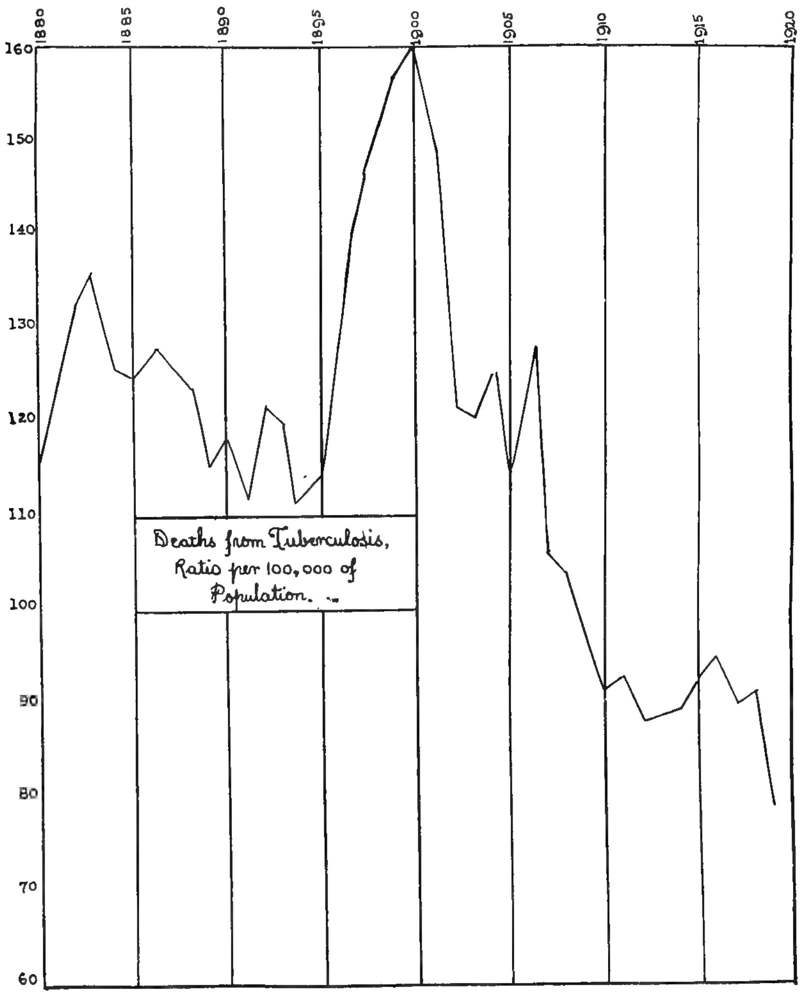

Fig. 12.

conclusion that there are 10 clinically active cases and 10 less obviously active and arrested cases for each death, there would be in Canada at present 200,000 cases of tuberculosis. Figs. 10, 11, and 12

TABLE XXV

Year	Total	Ratio per 100,000	UNDER 5 YEARS 0—1	1	2	3	4	5—9	10—14	15—19	20—29	30—39	40—49	50—59	60—69	70—79	80 and Over	Not Stated	Total Deaths From all Causes
	23,747		539	364	235	142	156	472	615	1,893	6,496	4,914	3,127	2,177	1,514	684	135	294	341,323
1910	2,291	102	38	35	19	15	6	36	55	184	652	463	293	222	160	71	18	24	31,332
1911	2,353	92	63	30	15	10	18	48	64	181	618	476	325	218	156	85	12	34	31,878
1912	2,250	87	53	30	19	9	15	46	42	154	631	500	304	200	134	64	7	42	32,150
1913	2,294	85	52	36	20	10	18	32	41	188	632	479	313	204	156	56	10	47	34,317
1914	2,340	85	54	41	20	16	11	56	58	131	688	469	307	214	116	63	12	34	32,440
1915	2,466	89	79	39	25	19	16	55	74	168	676	516	273	242	176	73	15	20	33,294
1916	2,559	92	66	43	35	19	9	53	61	224	683	536	327	238	156	68	17	24	35,580
1917	2,460	88	51	43	26	19	11	45	70	196	664	490	351	240	144	72	18	20	33,284
1918	2,519	89	39	35	35	13	27	40	86	242	677	526	323	207	161	66	15	27	43,038
1919	2,215	78	44	32	21	12	25	61	54	175	575	459	311	192	155	66	11	22	34,010

have been prepared to illustrate the Ontario mortality from tuberculosis, all forms, for the years 1880-1918 inclusive.

From the report of the Registrar General of Ontario for the year 1919, the following additional data has been obtained showing the distribution, ratio, etc. This shows a fall for 1919 to 78 per 100,000 of population, as compared with 89, in 1918.

This is the lowest rate ever recorded in the Province of Ontario.

Age Distribution of Deaths

An important fact is that the largest number of tuberculosis deaths are registered before the end of middle life. A series of graphs to illustrate this show that there are more deaths from this

PHTHISIS DEATH RATES, MALES, IRELAND 1881-1910

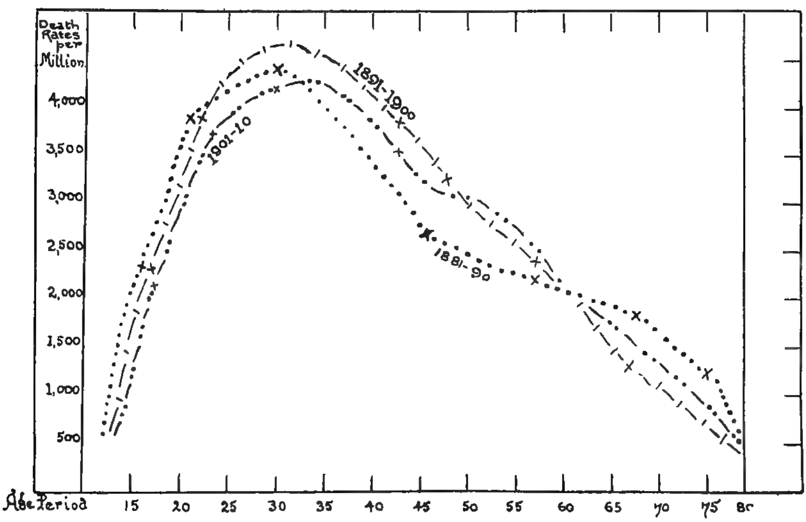

Fig. 13.

cause between the ages of fifteen and forty-five than at any other period. Just at the time of life when the individual should be most productive, death from a preventable disease occurs.

Figs. 13, 14, and 15 are taken from the most exhaustive studies of the epidemiology of tuberculosis in Great Britain and Ireland; these were made by Brownlee, for the Medical Research Council. The

reader is referred to these publications for much illuminating information based upon the experience in the British Isles, during the last 125 years.

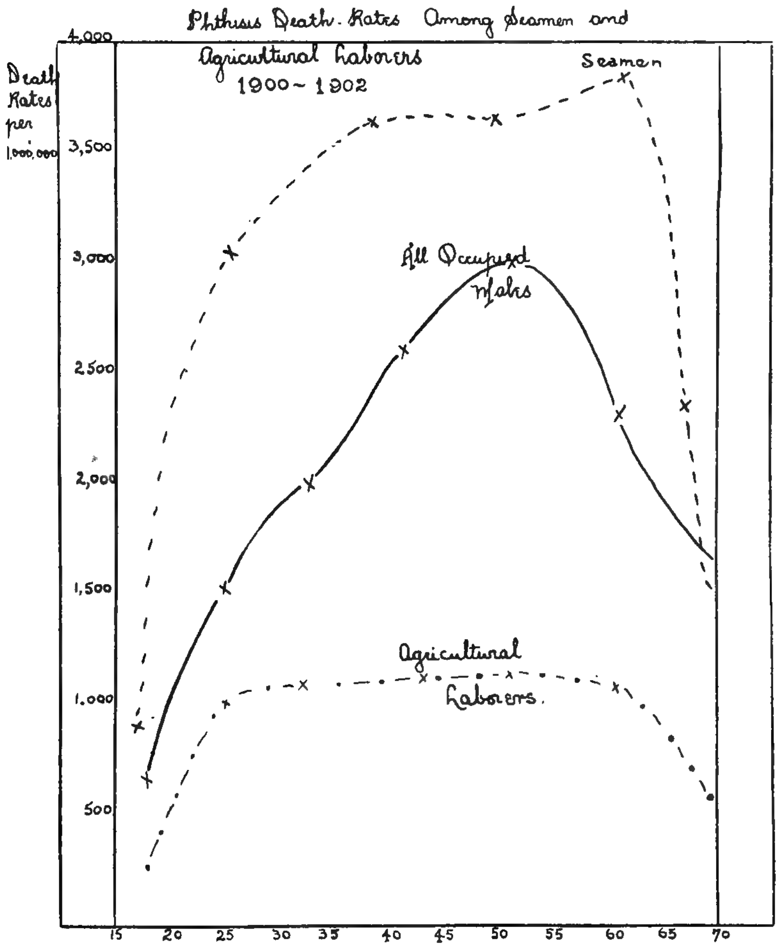

Fig. 14.

Figs. 16, 17, and 18 are reproduced from a memorandum on tuberculosis issued by the General Medical Department (Department of Child Welfare and Tuberculosis) of the League of the Red Cross Societies, March, 1920.

Etiology

Either the human or bovine strain of bacillus tuberculosis may give rise to the disease in man. In those persons in whom *tuberculous infection* develops into *tuberculous disease,* there is a disturbance in the balanced parasitism existing between the human host on the one hand and the tubercle germ on the other. As a result, the symptoms of tuberculosis become manifest. This view which in essence is that enunciated many years ago by Theobald Smith prob-

PHTHISIS DEATH RATES, FEMALES, SCOTLAND 1861-1910

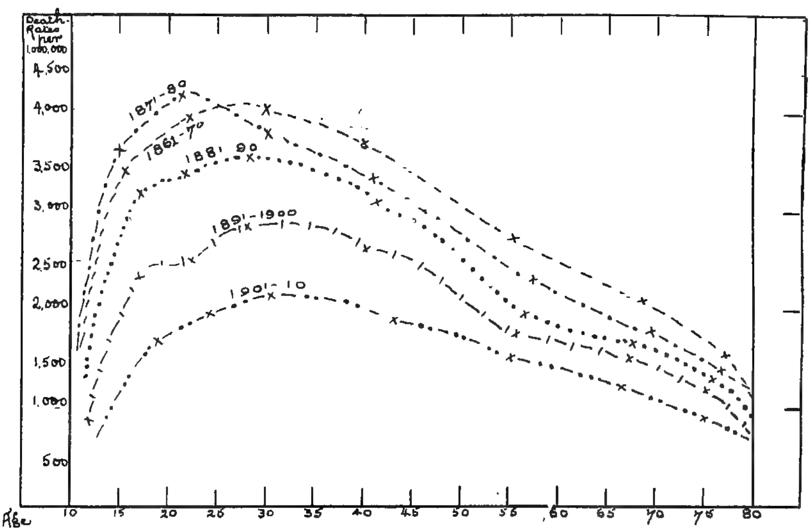

Fig. 15.

ably gives us the most adequate conception of the natural history of the disease. Opie has quite recently pointed out that only the limitations in our diagnostic equipment, clinical, laboratory and radiographic, make it difficult to decide in whom, and under what circumstances, the implantation of the germ is a menace, and when no baneful effects are likely to ensue. In other words, if the germ gains the victory, definite pathological lesions result; associated with the outcome are the varied signs and symptoms. The latter may, however, be so slight as to remain unnoticed by the patient for a very considerable period of time.

The many and varied factors of infection and resistance, in other words, differ quantitatively, at least, in different individuals, and the thing which ultimately turns the tide in favor of infection is of too subtle a sort to be recognized; so we remain in doubt until gross anatomical or serological changes supervene. Then it can be

DEATHS FROM TUBERCULOSIS OF ALL FORMS AT EACH AGE UNDER 45 YEARS IN NEW YORK CITY, 1913-1917

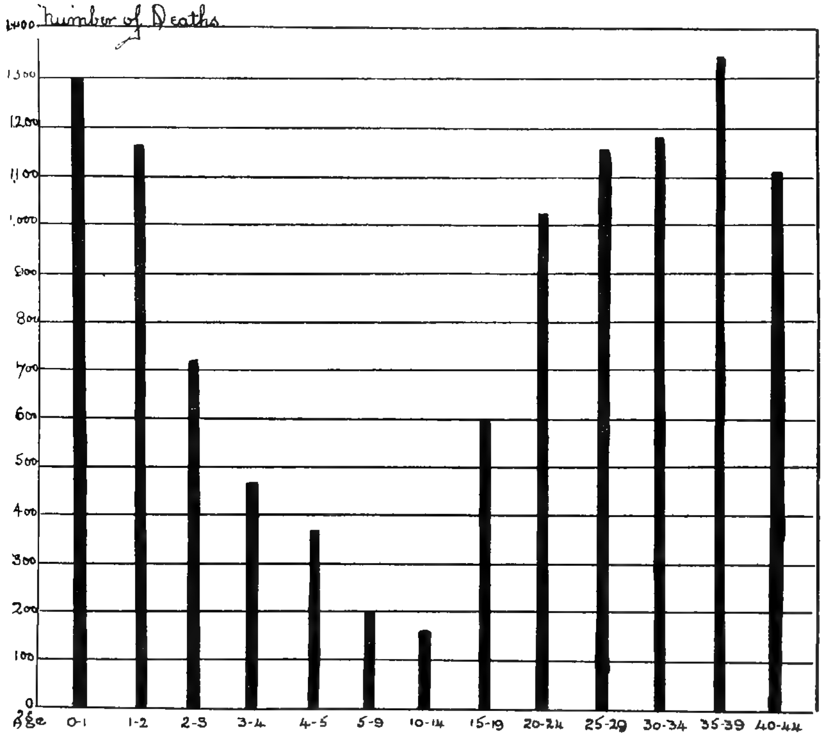

Fig. 16.

ascertained that tuberculous infection has indeed become tuberculous disease.

Since we have 2 distinct types of germ which may give rise to the disease under favorable conditions, what number and kind of infections are due to the human strain, and what to the bovine?

DEATHS FROM TUBERCULOSIS OF ALL FORMS BY AGES OF LIFE, CITY OF PARIS, 1913

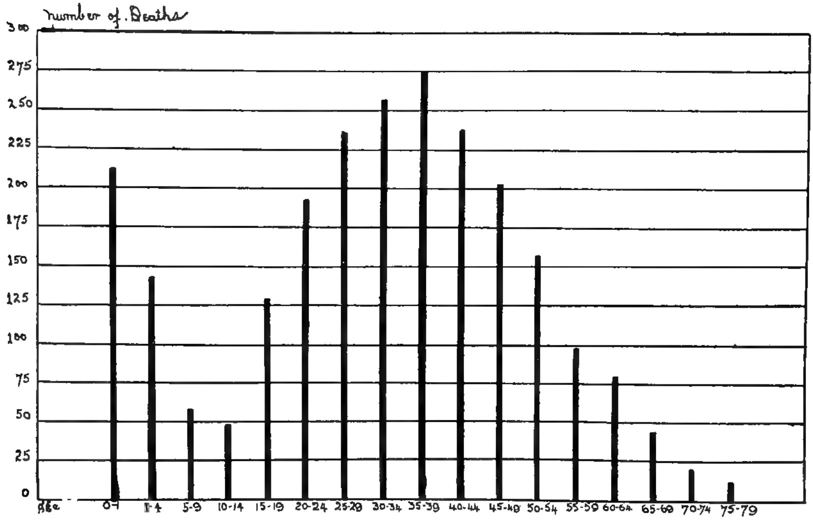

Fig. 17.

DEATHS FROM TUBERCULOSIS OF ALL FORMS BY AGES OF LIFE, ENGLAND AND WALES, 1913-1917

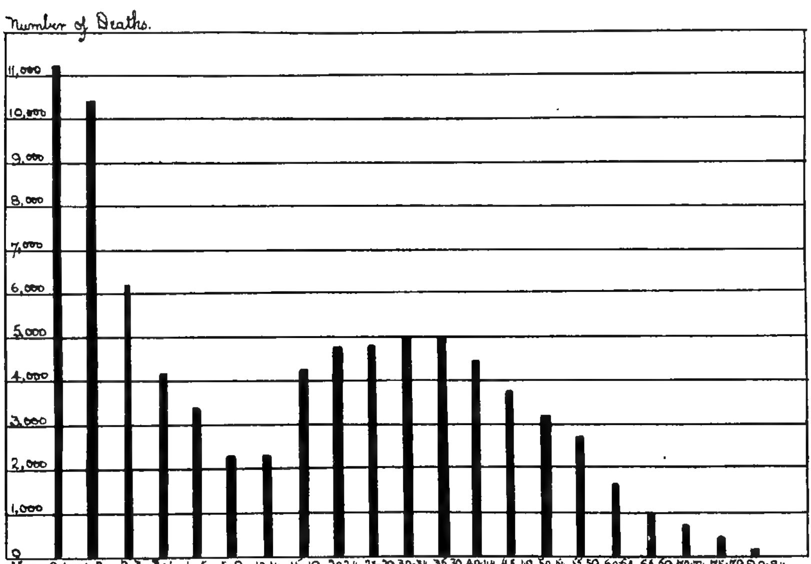

Fig. 18.

Much careful work has been undertaken by Commissions in England, in America and in Germany with the hope of answering this question.

TABLE XXVI. (FROM STANLEY GRIFFITH)

TABLE SHOWING THE RELATIVE INCIDENCE OF HUMAN AND BOVINE INFECTION AT VARIOUS AGE PERIODS IN A SERIES OF 68 CASES

AGE PERIODS	NUMBER INFECTED WITH HUMAN T. B.	BOVINE T. B.	T. B. DEAD IN—
Under 5 years	1 (10.0%)	9 (90.0%)	6 (37.4%)
5 to 10 years	7 (39.9%)	11 (61.1%)	8 (30.7%)
10 to 15 years	8 (61.5%)	5 (38.5%)	5 (27.7%)
15 to 20 years	6 (60.0%)	4 (40.0%)	2 (16.6%)
20 and upwards	13 (76.5%)	4 (23.5%)	5 (22.7%)
Totals	35 (51.5%)	33 (48.5%)	(26 plus 3 in which age not stated, 30%)

TABLE XXVII. (FROM PARK AND KRUMWIEDE)

COMBINED TABULATION OF CASES REPORTED AND THEIR OWN SERIES OF CASES

DIAGNOSIS	ADULTS 16 YRS. & OVER		CHILDREN 5 TO 16 YRS.		CHILDREN UNDER 5 YRS.	
	HUMAN	BOVINE	HUMAN	BOVINE	HUMAN	BOVINE
Pulmonary Tuberculosis	778	3	14	—	35	1
Tuberculosis adenitis, axillary or inguinal	3	—	4	—	2	—
Tuberculosis adenitis cervical	36	1	36	22	15	24
Abdominal tuberculosis	16	4	8	9	10	14
Generalized tuberculosis	6	1	3	4	17	15
Alimentary origin generalized tuberculosis	29	—	5	1	74	7
Generalized tuberculosis including meninges, alimentary origin	—	—	1	—	5	10
Generalized tuberculosis including meninges	5	—	10	—	76	1
Tubercular meningitis	1	—	3	—	28	4
Tuberculosis of bones and joints	32	1	41	3	27	—
Genitourinary tuberculosis	22	1	2	—	—	—
Tuberculosis of skin	10	3	4	6	2	—
Miscellaneous cases—						
Tuberculosis of Tonsils	—	—	—	1	—	—
Tuberculosis of mouth and cervical nodes	—	1	—	—	—	—
Tuberculosis sinus or abscess	2	—	—	—	—	—
Sepsis, latent bacilli	—	—	—	—	1	—
Totals	940	15	131	46	292	76

Mixed or double infection, 11 cases

Total Cases—1,511.

The accompanying tables (XXVI, XXVII, and XXVIII) taken from papers of Stanley Griffith and Park and Krumwiede indicate:

(1) The relative incidence of human and bovine infection in a series of cases; (2) the type of clinical disease observed, and (3) the relations between age periods, type of infection, and clinical form in which the disease manifested itself.

TABLE XXVIII

SUMMARY OF SPUTUM INVESTIGATIONS IN PULMONARY TUBERCULOSIS SHOWING THE RELATIVE NUMBERS OF HUMAN AND BOVINE INFECTIONS. (STANLEY GRIFFITHS AFTER DIETERLEN AND LINDEMANN)

NAME OF INVESTIGATOR	NO. OF CASES	CLASSIFICATION OF CULTURES		
		HUMAN	BOVINE	MIXED
Various Authors	88	87	—	1
Dieterlen	50	50	—	—
Kitasato	152	152	—	—
Park and Krumwiede	296	296	—	—
Moellers	51	51	—	—
Jancso and Elfer	5	5	—	—
Commission Final Report	29	27	2	—
Kossel	46	45	—	1
Bulloch	23	23	—	—
Weber and Dieterlen	9	9	—	—
Lindemann	41	40	—	1
Own recent cases (London)	105	105	—	—
Own recent cases (Edinburgh)	43	42	1	—
Totals	938	932	3	3

One incompletely investigated case of Mohler and Washburn excluded.
The de Jong-Stuurman Case.

Park's conclusion "that about 10 per cent of all deaths caused by tuberculosis in children under five years of age is due to bovine infection, when the milk is not pasteurized," is significant in reference to the question of prevention and control of tuberculosis. In this, as in other fields of preventive medicine, certain measures are immediately applicable, administratively possible, and within the realm of present day practicability. Others must stand over until tomorrow for solution.

Park has also shown the percentage of bovine infection in Table XXIX; arranged according to the more important clinical types of the disease, and to ages and persons infected.

No one doubts that when education in personal hygiene is carried to the point where every one in the community knows how tuber-

Table XXIX

Percentage of Bovine Infection* (Park)

DIAGNOSIS	ADULTS 16 YEARS AND OVER	CHILDREN 5 TO 16	CHILDREN UNDER 5
Pulmonary tuberculosis	0† per cent	0 per cent	0 per cent
Tuberculosis adenitis, cervical	4 " "	37 " "	57 " "
Abdominal tuberculosis	16 " "	50 " "	68 " "
Generalized tuberculosis	3 " "	40 " "	26 " "
Tubercular meningitis (with or without generalized lesions)	0 " "	0 " "	15 " "
Tuberculosis of bones and joints	5 " "	3 " "	0 " "

*Exclusive of the cases of double infections. In considering the pulmonary cases it must be remembered, however, that bovine tubercle bacilli have been isolated from the lung in cases of generalized tuberculosis in children.

†If one doubtful case admitted, 0.2 per cent.

culosis is spread, and how it can be controlled, when housing conditions are improved and when malnutrition is greatly decreased, the incidence of, and deaths from, this disease will be vastly reduced. Some of these things are not of the millennium; they will come in time and at a rate which will harmonize with the effort put forth to achieve them. What can be done almost immediately in any community, is to make it impossible for children or adults to acquire bovine tuberculosis. People can at once be taught the facts, and the methods of eradicating that type of infection.

Physicians should take an active part in the campaign to effect this. They should be the leaders in the movement. It is their opportunity to indicate to their patients that tuberculosis is a disease in which, usually, implantation of the germ, or infection, occurs in childhood. That the germs come either from human beings, or from cows with tuberculosis, and that even though all human sources of infection may not at once be brought under control, it certainly is expedient to immediately endeavor to control the bovine source of infection by the simple procedure of pasteurization of the milk supply.

Modes of Transmission

From what has just been emphasized it will be evident that the germs of tuberculosis are conveyed to human beings, from (a) other infected human beings, or (b) from cows. These are the only sources of reservoirs of infection. As a rule one human being infects another with the germ of the disease when the first person is in any

of the stages of the disease in which tubercle bacilli are present in the sputum. Such persons are known as "open cases" of tuberculosis. They are the most active distributors of the seeds of the disease. The foci of infection in the lungs have as a result of the anatomical progress of the disease, come into open communication with bronchi, and in coughing, spitting, sneezing and loud speaking, the germs are carried in fine droplets, to others in immediate association. They enter the mouth or nose of such, or are conveyed there by fingers, and enter the body in inhalation or ingestion and thus become implanted.*

Whether the germs are inhaled or swallowed makes no essential difference, once they enter, they are in a position to further penetrate the body. The various stages, in the development of infection and disease between the time the germ enters the mouth or nose, until symptoms of the condition appear are not as yet entirely elucidated. Calmette's recent monograph is of much interest in this connection. These open cases of the disease are obviously the greatest possible menace to those with whom they are in constant and intimate association.

Children are subject to the greatest dangers for many reasons. If of a stock that has an hereditary predisposition to the disease (with which certain persons are born), repeated implantations may set up infection, which may go on to the stage of frank tuberculous disease, either at once or later in life, as the result of a breakdown of resistance.

On the other hand a single implantation may stimulate the forces of resistance, and unless repeated and intensive exposures to tuberculous infection are encountered, the individual will, as do 90 per cent of us at the present time, die of some other disease. The method of infection in tuberculous disease of organs other than lungs, is essentially the same as in lung disease. In these cases death, fortunately, is not so often the sequel, but grave degrees of disability very often result.

*The importance of the inhalation of dust, etc., containing tubercle bacilli in the transmission of the disease was for many years insisted upon by Cornet. The idea of "droplet" infection, as opposed to the inhalation theory was first enunciated by Flügge, whose contributions to the subject should be consulted by all those interested in the development of the present views in regard to droplet infection in the transmission of communicable diseases of the respiratory tract. Calmette and von Behring have been the advocates of the ingestion theory of infection; holding that the germs whether of the bovine or human type are swallowed, and gain an entrance into the body through the intestinal mucosa.

Tuberculous disease of parts or systems of the body other than the lungs is essentially the same as in pulmonary diseases, that is, implantation of the tubercle bacilli must take place. Just why in one individual the genitourinary, in another the cutaneous or lymphatic system becomes diseased and remains the important and perhaps the only system involved, is not thoroughly understood.

The second source of tuberculous infection: The germ of bovine tuberculosis is conveyed to man in milk from cows suffering from the disease. Here, of course, the germs are swallowed. An enormous proportion of milch cows suffer from tuberculous disease,—in many communities, as high as 30 to 40 per cent. It is not remarkable, therefore, that many children are infected with the germs of bovine tuberculosis, in those communities where pasteurization of public milk supplies is not yet required. It is probable that not many cases of human tuberculosis develop as a result of the consumption of the meat of tuberculous cows; though this *is* another possible source of infection.*

A matter of prime importance in the consideration of modes of transmission is that relating to the viability of the germ of tuberculosis outside the human or animal body. How long will it live? As long as it has food and moisture, and is protected from direct sunlight. In sputum which is not completely dried up, if not exposed to sunlight the germs may live for months, and as has been shown by experiment even for years. No specific answer in terms of days or weeks or of months can be given to this question, however. The factors will probably in no two instances be precisely similar as to the number of germs originally deposited, the presence or absence of sunlight, conditions likely to cause the immediate drying of the sputum, etc. The essential point is that the germs of the disease on objects in the environment are less commonly the source of infection than are those given off at all times by open cases, with which we are constantly coming in contact. The germ is destroyed by heating to 60° C. for twenty minutes (moist heat). Direct sunlight kills the germs in sputum within a few hours, and 5 per cent carbolic acid solution mixed with equal parts of sputum will kill the germs within twenty-four hours.

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*To assist in overcoming the menace of bovine tuberculosis, the government of the Dominion of Canada has provided a plan of compensating owners of tuberculous cattle, if such are slaughtered. Details of this may be obtained by applying to the Veterinary Director-General, Department of Agriculture, Ottawa, Ont.

Prevention and Control—General Considerations

Much stress has been laid, recently, upon the fact that the tuberculosis death rate has been declining in certain parts of the world where the disease has long been prevalent. Many observers have emphasized this fact, and Rosenau in considering the question writes: "The decline (in death rate from tuberculosis) may have been little influenced by any of the usually assigned causes but may simply be a biological phenomenon indicating a falling off in the virulence of the tubercle bacillus." A consideration of the results obtained in certain communities where intensive antituberculosis work has been carried on contrasted with areas where nothing has been done, would seem to controvert such an opinion.

The Dominion of Canada, which, in area, covers half a continent, varies greatly in climate, is populated chiefly by 2 races of people among whom the disease has been prevalent for decades, and in addition, by a number of primitive peoples, North American Indians and Esquimaux. Conditions are therefore ideal for observing the effects of specific measures elaborated for the prevention and control of tuberculosis.

Now, there are two general factors of the utmost importance in considering these questions. The first is exemplified in considering the effect of the disease on the Indians and Esquimaux in Canada. Among both of these primitive peoples it has made frightful inroads and has demonstrated the results of tuberculous infection on virgin soil. And, as Sir Robert Philip has recently restated, the incidence of tuberculosis is determined by just two factors, the presence of infection, and the suitability of soil. The consequences of tuberculosis among the Indians and Esquimaux in Canada are roughly comparable to those cited by Cummins in his paper dealing with the effects of the disease on native troops in the British Army in France during the Great War, and by Borrel who has summarized the experiences of the Senegalese troops in the same theatre of war, in the years 1914-1918.

Here we have acute pulmonary tuberculosis with high death rates and the only parallel condition among civilized peoples, long exposed to infection, is seen in acute pulmonary tuberculosis, in childhood.

Over and above this somewhat limited volume of tuberculosis of

the primitive type in Canada, there has been for many years, much tuberculosis of the type which prevails among people long exposed to infection, which is manifestly one of a chronic character and showing a distinct tendency to spontaneous recovery (Caulfeild). What is the extent of this at present? and what, if any, signs are there that antituberculosis measures have in any direct fashion influenced the deaths from, or the incidence of, tuberculosis?

It must be admitted at once that data as to increase or decrease in the morbidity from tuberculosis is not available. Whether we now have more or fewer cases of the disease than we had twenty-five years ago cannot be definitely ascertained. However, some figures are at hand showing the influence of an all-round antituberculosis program on a community of 500,000 people, namely, the city of Toronto.

In 1911, there was in Toronto, no systematized, broadly-planned scheme for dealing with the positive or suspect tuberculous. Sanatorium beds there were for adults, and two or three out-patient clinics existed in general hospitals where diagnostic facilities were provided. But practically no follow-up work or searching out of contacts, was attempted; malnourished and tuberculin-positive children were not being reached, and public health nursing and school medical inspection had just been started.

Ten years have passed, and a really comprehensive plan has gradually emerged. Through the work of the Associated Tuberculosis Clinics, with their staff of expert clinicians, public health nurses, and social service workers, early diagnostic facilities and provision for the searching out of contacts, has been developed to a high point. These contacts also are detected and sent to dispensaries and clinics as a result of the work carried on by the Division of Medical Services of the City Health Department, in the public schools, where complete physical examinations of children reveal suspect cases. A preventorium of 100 bed capacity, for those tuberculin-positive, and often mal-nourished children contacts (in the case of boys to the age of twelve years and in the case of girls to the age of fourteen years) whose home conditions are not satisfactory, provides a place where rest, fresh air, good food and habits of healthful living may be inculcated; and also provides for a very special type of child as yet not clinically tuberculous, who otherwise would

probably be one of our cases of tuberculosis of tomorrow. Open-air school classes, and "forest schools," provide in a similar fashion regulated exercise and rest, fresh air and extra nourishment for children who need only supervision during the day, because general home conditions are fairly satisfactory.

There are provided, in addition, a large number of sanatorium beds for tuberculous cases in different stages of the disease, so that the open cases of tuberculosis, especially, may be removed from their environment, prevented from spreading the disease, treated, and at the same time taught those principles of personal hygiene which will be of benefit to themselves and of advantage to the community. A very important factor in the development of the antituberculosis crusade has been vigorous publicity work initiated by the Canadian Association for the Prevention of Tuberculosis, the National Sanitorium Association, The Samaritan Club, The Heather Club Chapter of the Imperial Order of the Daughters of the Empire, and other local agencies. The coordination has been effected by the Department of Health of the city and the workers about 100 in number, in the Division of Public Health Nursing of the Department have carried the antituberculosis message into thousands of homes and have played a conspicuous part in the campaign.

Thanks to the courtesy of Dr. A. Grant Fleming, Deputy Medical Officer of Health, of Toronto, Table XXX has been prepared to illustrate the measure of success which has up to the present attended the efforts put forth.

TABLE XXX

TUBERCULOSIS IN TORONTO—1911-1921

YEAR	CASES REPORTED	DEATHS INSIDE TORONTO	MORTALITY RATE PER 100,000	DEATHS OF TORONTO CITIZENS INSIDE CITY AND IN SANITARIA OUTSIDE CITY	MORTALITY RATE PER 100,000
1911	150 (6 mos)	374	100	466	124
1912	667	343	84	462	113
1913	580	329	74	467	105
1914	562	344	73	480	102
1915	639	343	74	476	103
1916	811	356	77	516	112
1917	904	327	69	492	104
1918	761	363	74	514	105
1919	616	304	61	427	85
1920	573	326 (Reg.)	64	429	83
1921	937	228	44	324	65

Enough has been indicated above to strongly suggest that broadly conceived, vigorously executed, antituberculosis work reduces the death rate from this disease. Similar data obtained from other communities in Canada convey the same impression. In a quarter of a century, from 1896 to 1921, in Canada, the number of sanatorium beds has been increased from 100 to about 4,000 for a population of about 8,000,000 people, or about 1 bed per 2,000 of population. There are now about 40 sanatoria or hospitals, and in addition, the country's resources in the way of dispensaries, clinics, preventoria, open-air schools, forest schools, etc., have been greatly increased and the expansion in trained personnel—clinicians, public health nurses, and social service workers—has kept pace, so that in the majority of the provinces satisfactory advances are being made.

It is true, however, that two or three provinces and some municipalities have lagged, and their tuberculosis records indicate it. In those places where money, energy, initiative, and enthusiasm in the crusade have been expended, the results indicate definite reductions in mortality; where they have not, tuberculosis continues to take its unnecessary toll. Not because of social conditions, race, or any undue susceptibility to the disease, but chiefly because of ignorance, and apathy, and an unwillingness to appropriate sufficient money to really cope with the menace of the great white plague. Public health in the especial field of antituberculosis work is purchasable, as in all others, and liberal appropriations will result in a reduction in the number of tuberculosis deaths.

It has been estimated recently that over one million dollars are spent annually in Canada for the maintenance of tuberculous patients, and that about three million dollars represent the investment in institutions for the care of the tuberculous. These facts, taken in conjunction with the points already indicated, that the annual number of deaths from tuberculosis in the country is about ten thousand and that there are from fifty thousand to one hundred thousand cases of the disease, emphasize the necessity for much more antituberculosis work in the Dominion of Canada.

Specific Control of Tuberculosis

Since cases of tuberculosis practically can arise only from (1) open cases of the pulmonary disease in human beings or (2) from

the ingestion of milk containing the bovine type of tubercle bacilli, the specific indications for measures to be initiated in any community are patent.

The physician should be the leader in his community in the war against tuberculosis, and of the utmost significance in the campaign is the early diagnosis of the disease. It is of vital importance, therefore, that the physician should have a thorough knowledge of the clinical and laboratory methods of proved value in the diagnosis of the disease in its early stages. He should remember that a thorough physical examination, a complete x-ray examination, a laboratory study of the blood by means of the fixation reaction and inhibitive reaction (Caulfeild) as well as a knowledge of tuberculin sensitiveness (by means of intracutaneous and von Pirquet tuberculin tests) in addition to a mere examination of the sputum for the presence of tubercle bacilli, are essential if tuberculosis is to be detected in the stage of minimal lesion.

Having diagnosed tuberculosis, the physician should consider the question of the further disposition of the case. He should report the case at once to the department of public health, or local board of health. The family should be instructed as to the proper method of dealing with the sputum from the patient, aseptic nursing must be insisted upon, *concurrent disinfection carried out,* and separate dishes provided, which should be boiled each time after being used by the patient.

Certain other measures should be instituted at once. If the case is an open one, sanatorium treatment may be recommended. Here the patient will be taught those things most likely to cure him or bring the disease to quiescence. Equally as important he will learn the precautions he must take to prevent the further transfer of infection. In any event, but particularly if the case requires sanatorium treatment the family as well should be taught the chief sources of danger and how they may be guarded against. This comprises the use of the sputum box or pocket flask, and the sterilization of the sputum* and the use of gauze which is inexpensive and can be burned after being used.

**Disinfection of Sputum.*—The disposal of sputum from a case of pulmonary tuberculosis is most important. Bed patients should have sputum cups placed on a table at the side of the bed. If the cups are made of wood fiber they may be burned when they have been used. Such cups are very convenient and satisfactory. If, however, sputum cups of a more durable character are used, they should contain a small quantity of 5 per cent carbolic acid solution, or 5 per cent chlorinated lime solution. These cups

It is certainly not necessary to send all cases of clinical tuberculosis to a sanatorium, but if this is not done, strong emphasis should be laid upon the importance of periodic examination by those competent to advise, not only for the benefit of the patient, but in the interest of public health. In determining the question of admission to a sanatorium, careful consideration must be given in each individual case, to all the facts elicited, clinical, social, and economic.

The physician should carefully examine all those who have been in close contact with the patient for any considerable length of time, paying very especial attention to the children. It is necessary also to impress upon other members of the family the possible significance of any loss in weight, cough, or other symptoms of the disease should such arise later. He may also suggest that the contacts should have thorough examinations at stated intervals. Especially is this desirable in members of families having a history of previous cases of the disease, and for the young children in the family. An intracutaneous tuberculin test, in addition to determining the weight and height of the child, should be made. Specific direction for the care of children contacts should be given to the parents. Rest, fresh air, good food, and periodic medical examination are all indicated, and the physician will be doing his whole duty only, when he makes known these essentials. In all places and at all times it should be recommended that only pasteurized milk be used where the milk is purchased from any public source of supply. Among patients residing in rural districts, the parents should be warned of the danger of using raw milk from tuberculous cows.

Many persons require to be specifically instructed as to the necessity of providing fresh air in living rooms, in winter as well as summer. The physician should himself advise concretely how an adequate supply of fresh air may be available at all times.

The physician, if he is also a good citizen, will take an active part in antituberculosis work in his community. Dr. Porter, formerly General Secretary of the Canadian Association for the Prevention of Tuberculosis, has prepared a diagram (Fig. 19) to illustrate the

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when they are less than half full of sputum should be boiled with their contents for ten or fifteen minutes; or if a sterilizer is available they may be disinfected in an autoclave at 15 pounds pressure for 20 minutes. Sputum cups are to be preferred to gauze or cotton wipes. If these are used, great care should be exercised to prevent their becoming dry, or soiling the hands either of the patient or others, and they should be boiled for 10 minutes after having been used.

varied activities which may, in any community, be directed toward the control of the disease.

In a municipality the tuberculosis situation may be such that provision for all these activities must be made. They may be operated, in part, under the direction of the medical officer of health, or, in part, working in close cooperation with him. In smaller municipalities, dispensary and sanatorium facilities may be shared jointly with other communities. In all, a public health nurse, for searching

SCHEME FOR COMMUNITY CONTROL OF TUBERCULOSIS

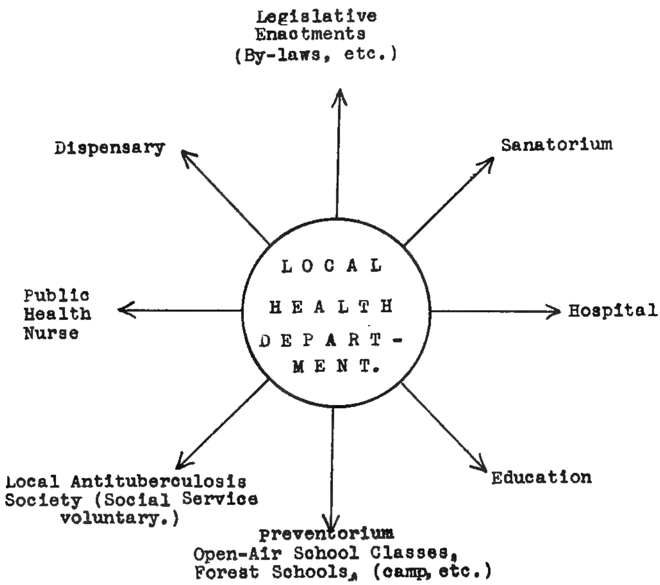


Fig. 19.—Diagram prepared by Dr. George D. Porter, formerly General Secretary, Canadian Association for Prevention of Tuberculosis.

out contacts and suspect cases is a prime necessity; and no political unit as large as a county should be without at least part of the machinery above indicated for the prevention and control of tuberculosis.

Abundant literature of a popular character dealing with the prevention of tuberculosis is now available, and this with poster exhibits, motion pictures and short talks should all be used to stimulate interest in the subject in a community, and provide an entrée into

the home for the public health nurse in order that the most effective propaganda may be carried on there.

PNEUMONIA

Under this designation there are included a group of clinical entities, which in morbidity and mortality reports, are not as a rule classified according to etiology, or clinical type of the disease. They are of the utmost significance from the standpoint of public health and are known to be very communicable—indeed one of the most fatal of all groups of transmissible diseases.

Incidence

Pneumonia (all forms) is now a notifiable disease, so that we are beginning to obtain information as to its prevalence, and in addition figures indicating mortality due to this cause. Pneumonia occurs everywhere, but is more prevalent in the cold and temperate climates than in tropical, or semitropical countries. In such communities it is more prevalent in the winter than at other seasons of the year. It is usually present in endemic form though occasionally definite epidemic outbreaks are reported. These are especially likely to occur among persons living in overcrowded quarters, or in barracks, etc., where adequate spacing-out, proper ventilation, etc., is lacking. Instances of such epidemics have been reported among laborers on the Panama Canal, also among the native workers in the diamond mines on the Rand, and most recently among troops in the United States Army Camps during the winter of 1917 and 1918. These epidemic outbreaks occur first of all because of the presence, in some considerable number of individuals, of the causative agent of a highly virulent type, and secondly, because conditions most conducive to the spread of the disease are present, such as unsuitable living quarters, with overcrowding, inadequate ventilation, etc. This is especially true when those so exposed are unused to such hardships, or are unseasoned.

In the registration area of the United States in 1919, pneumonia (all forms) was responsible for 105,213 deaths; which was 9.6 per cent of all the deaths recorded, and represents a 9.6 ratio of 123.6 per 100,000 of population. It was the third most important cause of

death. The deaths from pneumonia in Ontario during the years 1880 to 1919 are shown in Fig. 20 taken from the report of the Registrar-General, Ontario, for 1919. The following explanatory note is appended to the diagram. "Two particularly high peaks

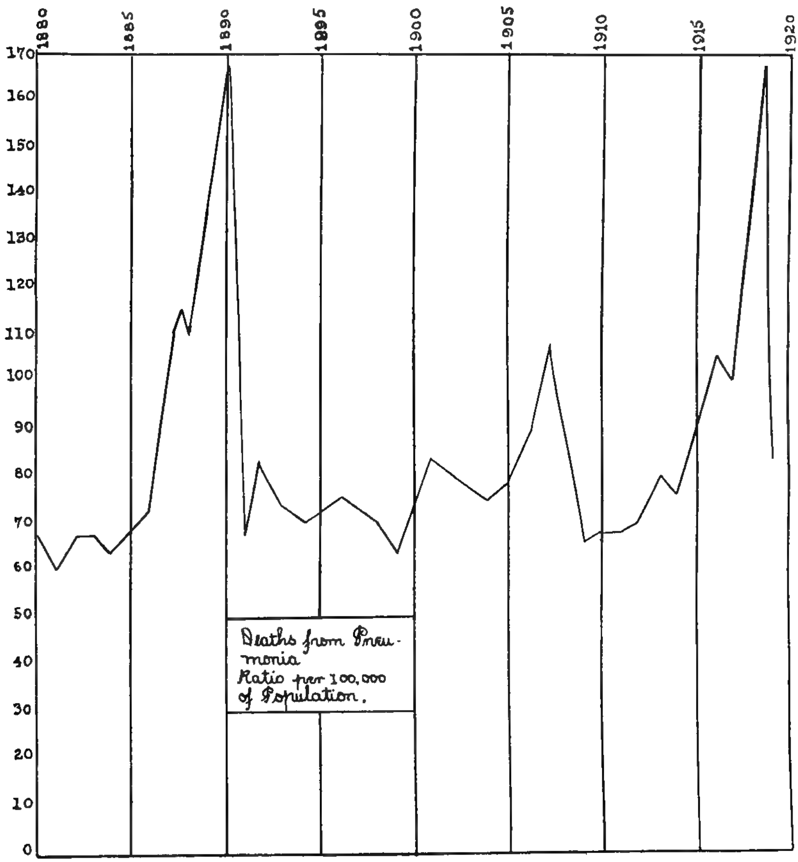


Fig. 20.

will be noted, that occurring in 1890 and that in 1918. The former is the result of an epidemic of la grippe and lack of care in classifying the actual cause of death. Many deaths were reported as 'pneumonia' or 'bronchitis,' one of these being the immediate cause, whereas 'influenza' was the primary cause. Also bron-

chitis is included in this peak, these two causes being classed together in that year. The second peak is due to the epidemic of influenza in 1918."

The total number of deaths and the ratio per 100,000 of population for the past decade are shown in Table XXXI.

TABLE XXXI

YEAR	NUMBER	RATIO PER 100,000 OF POPULATION
1910	1,558	66.5
1911	1,568	66.0
1912	1,629	63.0
1913	2,076	77.4
1914	2,009	73.0
1915	2,352	84.9
1916	2,912	105.6
1917	2,763	99.7
1918	4,660	166.5
1919	2,353	82.9

Etiology

Any one of a variety of microorganisms may be responsible for the production of the disease, the most common being the pneumococcus and streptococcus. Our knowledge of the etiology and epidemiology of pneumonia has been very considerably extended as a result of a series of fruitful researches carried out by Cole, Avery, Gillespie, Chickering and Dochez in the Rockefeller Institute and Rockefeller Hospital. Their monograph on the subject is most exhaustive, and should be consulted. Briefly, following the work of Neufeld, these observers pointed out that the pneumococci could be grouped according to their serum reactions. As a result

TABLE XXXII

Diplococcus pneumoniae	454
Streptococcus pyogenes	7
Bacillus influenzae	6
Friedlander's bacillus	3
Staphylococcus aureus	3
Streptococcus mucosus	1
Mixed infection with combinations of Staphylococcus aureus, Friedländer's bacillus, B. influenzae, St. pyogenes and St. viridans	6
Undetermined	49
Total	529

three types of pneumococci, and a fourth group have been differentiated.

In the monograph above referred to among 529 of acute lobar pneumonia, the microorganisms listed in Table XXXII were found to be the etiological agents.

Approximately 90 per cent of cases of lobar pneumonia, therefore, are due to the pneumococcus. The streptococcus is much more frequently the causative agent of certain types of lobular pneumonia, as has been emphasized by McCallum in his recent work. Whatever the clinical variety of pneumonia, however, it is due to some germ, and is a transmissible disease.

Modes of Transmission

Pneumonia is usually transmitted *directly*, by droplet infection, the germs being present in the mouth, nose and throat secretions of patients, contacts and carriers, and are conveyed to others, in coughing, spitting, sneezing and loud speaking. It may also be transmitted indirectly (but probably much less commonly) by articles soiled with secretions containing pneumococci, etc. The important sources of infection are undoubtedly (1) patients suffering from acute lobar pneumonia (2) contacts of such patients, (3) carriers, and (4) persons suffering from "colds," rhinitis, pharyngitis, laryngitis or mild bronchitis due to pneumococci. The exact incubation period of pneumonia is unknown.

Prevention and Control

There is almost no other disease of the group at present being considered, which it is more important to attempt to control than pneumonia. The view that it is highly communicable and a most dangerous transmissible disease should be widely disseminated everywhere. One attack of the disease confers no immunity; on the contrary, it may indeed predispose to subsequent attacks.

It is the physician's duty to immediately isolate every case of pneumonia, to report the case to the health department, and take every possible precaution to prevent further spread of the disease. Aseptic nursing, with all that it implies should be carried out, and masks should be worn when in contact with the patient. Concurrent disinfection should be practiced, and instructions given to destroy all mouth and nose secretions.

In camps, etc., overcrowding should be avoided, proper spacing out of beds in sleeping quarters (not less than 800 to 1,000 cubic feet per man) provided, and in such quarters, adequate arrangements for proper heating, ventilation, etc., should be made. Furthermore, in such quarters, spitting, etc., should not be tolerated. Men should be warned of the danger of coughing, sneezing and spitting promiscuously.

It is indeed necessary that an intensive educational campaign be carried on in the schools, homes, factories, and elsewhere, by physicians, public health nurses, and social workers, to take to the general public knowledge of the facts of how pneumonia is spread, and how infection may be avoided.

In large centers of population, serious overcrowding in stores, on street cars, etc., is very difficult to avoid, and for that reason very especial care should be taken by those suffering from colds or other respiratory infections, to avoid infecting other persons. This they will do only when sound health habits are established in early childhood. For that reason public health education in all these matters should be initiated among children in the schools.

Specific Prophylaxis

Vaccination with fixed types of the pneumococci, (pneumococcus bacterial vaccines) have been tried with a certain measure of success. The specific treatment of cases of lobar pneumonia due to pneumococcus Type I with a Type I antipneumococcus serum has proved to be especially valuable in many cases. Serum treatment for Types II or III or Group IV pneumococcus infections so far is ineffective.

INFLUENZA

Influenza is an acute disease or group of conditions, highly communicable and characterized by pandemic manifestations at widely separated intervals of time.

Incidence

It is exceedingly difficult in the present state of knowledge of
Until the cause is known, or at least additional data available by
the disease to give any data of assured value as to its prevalence.

means of which a diagnosis of influenza may with certainty be made, this will continue to be true. Park has indicated another difficulty in dealing with influenza in the following words: "There is no known laboratory method by which an attack of influenza can be

DEATHS FROM INFLUENZA

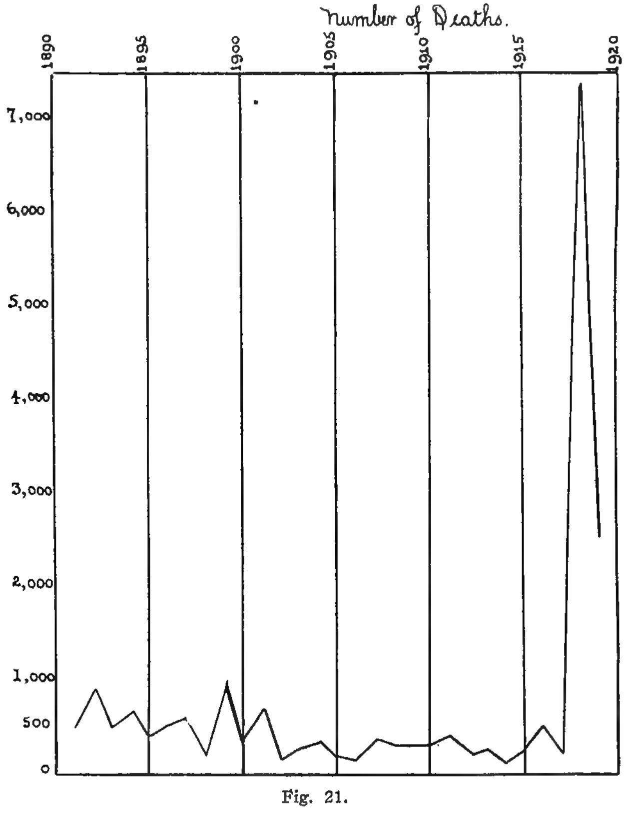


Fig. 21.

differentiated from an ordinary cold or bronchitis or other inflammation of the mucous membranes of the nose, pharynx or throat." "There is no known laboratory method by which it can be determined when a person who has suffered from influenza, ceases to be capable of transmitting the disease to others."

However, in times of epidemics, the major manifestations and the clinical and pathological pictures permit us to assume that a

condition or group of entities which we now designate influenza, is present and warrants endeavoring to do all that is at present possible to limit the further spread of the disease and diminish the

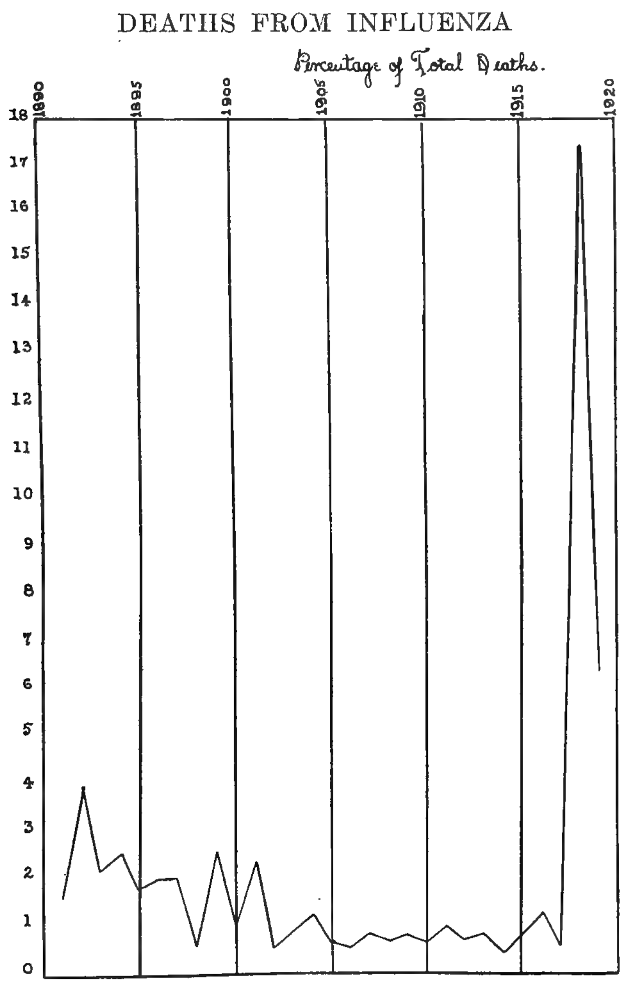


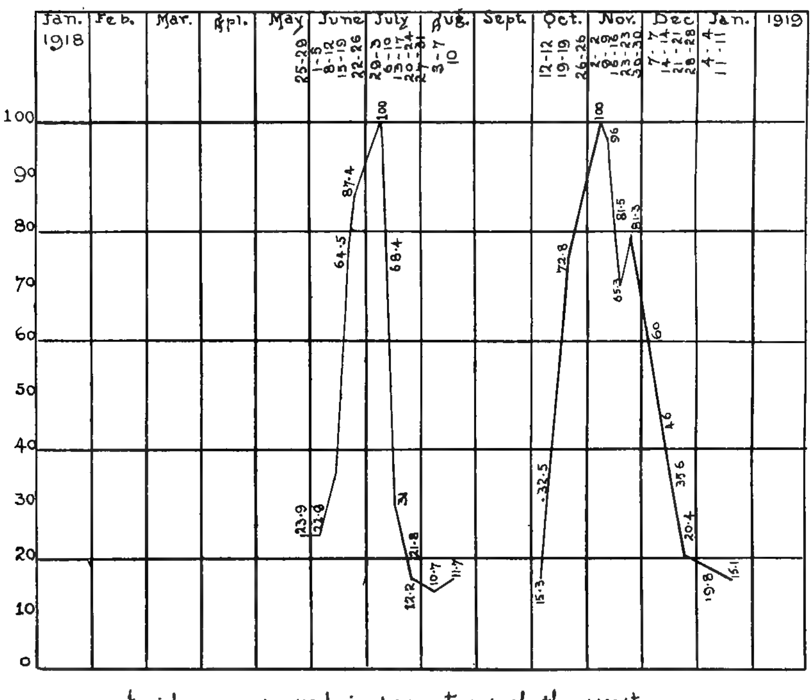
Fig. 22.

number of deaths due primarily, or secondarily thereto. In the registration area of the United States in 1919, there were registered 84,113 deaths which were attributed to influenza; this was 7.7 per

cent of the total deaths in the registration area and a ratio of 98.8 per 100,000 of population.

In 1920, in the Province of Ontario 24,284 cases of influenza and pneumonia were reported as is indicated in Table XIII. Figs. 21 and 22 illustrate the mortality experience in Ontario from deaths as being due to influenza.

WEEKLY INCIDENCE CURVES OF SUMMER AND AUTUMN INFLUENZA EPIDEMICS—B. E. F., FRANCE



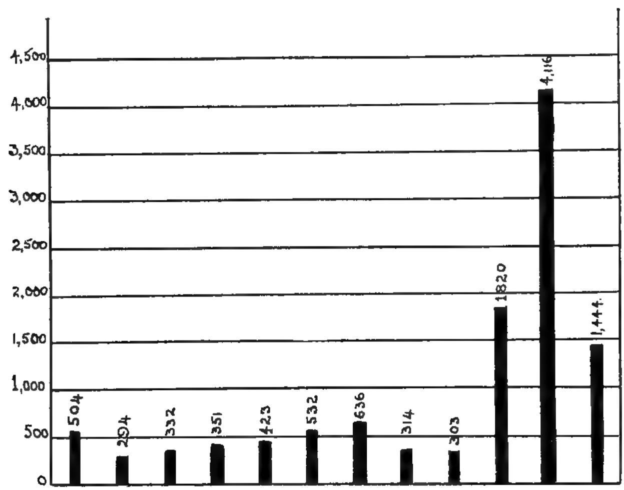
Incidence expressed in percentages of the worst week taken as 100.

Fig. 23.

Very interesting observations on the incidence of the disease in the British Expeditionary Force in 1918 were made by Captain M. Greenwood, R. A. M. C., who observed that "the fundamental characteristics of a primary epidemic are a very high attack rate and an approximately symmetrical distribution in time. . . . .

the graph of the epidemic is an almost symmetrical curve the fatality (rate) is low, rarely more than 1 per cent of the cases. A secondary epidemic effects a relatively small proportion of the population; is slower in reaching its maximum; and thereafter declines slowly and irregularly, more slowly than it increases; its distribution is asymmetrical; and there is less concentration around the maximum. Further a secondary epidemic is characterized by a vastly higher fatality than a primary epidemic."

TOTAL DEATHS PER MONTH FROM DISEASES IN BASE HOSPITALS AND C. C. STATIONS



Shows marked effect of Autumn Epidemic on Total Deaths from Disease.

Fig. 24.

It is to be remembered that the primary wave of the epidemic in the B. E. F. occurred in June, 1918, and the secondary devastating wave in October, November and December, 1918. This secondary wave swept over the entire world with most disastrous consequences. The graphs prepared by Greenwood to illustrate the above are herein reproduced. (Figs. 23 and 24.) (From Special Report Series No. 36 "Studies of Influenza in Hospitals of the British Armies in France, 1918." National Health Insurance Medical Research Committee.)

Etiology

The cause of influenza is at present unknown. It may be that the etiological agent is (a) an unknown filtrable virus, or (b) B. influenzae or (c) Bacterium pneumosintes (Olitsky and Gates). Until the appearance of the epidemic of 1918, B. influenzae was generally accepted as being the agent responsible for the production of the disease. This view is still held by many, and the recent work of Cecil, Blake, and others supports such a view. Since the experiments of Nicolle, Gibson, and Bowman and others, however, there are those who hold that a virus of an unknown sort, a so-called "filter passer" is the primary cause of the disease and B. influenzae only one of the secondary invaders. Bronchial secretions from patients suffering from the disease frequently show the presence of B. influenzae, and one or more types of pneumococcus, streptococcus, etc.

Modes of Transmission

Influenza is most highly communicable, and this is especially true during periods when the disease is epidemic or pandemic. It then spreads everywhere among all people without reference to climate, season, or race. It is quite generally agreed that the disease is spread only by transfer of mouth and nose secretions, from infected persons (patients suffering from the disease, or carriers) to susceptible persons by *direct contact,* through droplet infection, in coughing, sneezing, spitting, etc., or secretions carried to the mouth or nose in kissing, etc., or by hands wet with such secretions. Indirect transmission may, of course, occur if articles wet with secretions containing the etiological agent of the disease are conveyed to the mouth or nose of susceptible persons.

Methods of Control

No satisfactory method of control of influenza has as yet been elaborated. However, if the physician has reason to suspect that a patient is suffering from influenza, he should at once

(1) Isolate such a patient,

(2) Report the case to the local health department,

(3) Give explicit instructions to those who are caring for the patient to exercise every precaution to avoid infection, by wearing

a mask and gown when in attendance on the patient; to destroy the nose and mouth secretions of the patient; to wash the hands every time they have become contaminated with the patient's mouth or nose secretions; and to insist upon the use of separate dishes, etc., and upon their being boiled after being used. Finally by attention to the details of aseptic nursing and concurrent disinfection in all aspects, further transmission of the disease may be prevented.

All those who show what may be early symptoms of the disease should be advised to go to bed at once. If the symptoms develop further, they should then be isolated immediately. Early recognition, with consequent notification and isolation is most important. If all persons who have been exposed to infection in crowded shops, street cars, etc., would wash the face and hands on returning home, certain cases would be prevented, and if those who could possibly do so, would, for a short time, avoid crowds, by walking to work, and reduce shopping to a minimum in crowded places during the height of the epidemic, much benefit would accrue. Obviously places of amusement, if crowded, need not be patronized while the disease is raging in epidemic form. The precautions consist simply in the application of the principles of sound common sense based on our present conceptions of the mode of transmission of the disease.

Since the majority of persons who develop influenza and ultimately succumb, do so because of a complicating pneumonia or bronchopneumonia, physicians should strongly emphasize to their patients the desirability of going to bed as soon as symptoms appear and remaining there until convalescent. These complications, pneumonia and bronchopneumonia, are usually due to pneumococci and streptococci and cause very many deaths, especially among those who have neglected early treatment.

By attention to all conditions which favor the maintenance of normal resistance, such as rest, fresh air, nourishing diet, avoidance of exposure, overindulgence in alcohol, etc., a certain amount of good may be accomplished.

A word as to the use of bacterial vaccines in the prevention of influenza. It is the opinion of the majority of observers that there is no vaccine that can be regarded as a specific preventive of influenza itself. On the other hand there is considerable evidence which indicates that vaccines freshly and properly prepared from fixed

types of pneumococci and streptococci, especially, may have value in the prevention of complications. In this connection it is important to remember that such vaccines only produce an immunity when three or four doses have been administered at intervals of about five days. Furthermore, a period of ten days to three weeks probably elapses after the injections have been completed, before protection is conferred. Because of this fact the attempt to immunize those who may be already developing the disease is not at all likely to be successful.

In a time of an epidemic of influenza a special emergency organization may be required in any community to provide medical and nursing service, and even domestic assistance, or food, for those families, in which all members may be stricken with the disease. It is the duty of the local health department to organize this, and to request the assistance and cooperation of all local voluntary societies, etc. A public meeting to perfect such an organization and assign duties is a useful initial step and should be taken as soon as the disease appears in any municipality.

Those interested in further details of methods proposed for the control of epidemics of influenza are referred to the Report of the Special Committee of the American Public Health Association appointed to consider this question.

BRONCHOPNEUMONIA, ETC., IN INFANCY AND CHILDHOOD

In nearly all communities respiratory infections take a very large toll of infant lives. In the Province of Ontario in 1919, 7,849 children under the age of five years died; (total deaths at all ages, for the same year, 34,010). Of this number 1,195 died of diseases of the respiratory system, exclusive of influenza, and 448 others died from this cause making a total of *1,643* or about *20* per cent.

The diseases are probably all due to the transmission of infection to very young children by older children or adults and are in large part preventable. The transfer of mouth and nose secretions containing virulent pneumococci, streptococci, influenza bacilli, etc., is undoubtedly the cause of a large majority of these unnecessary deaths. Physicians should emphasize the great danger of these infections in little children; and since they occur in children of pre-school age, the transfer of secretions containing such germs to nose and mouth can be prevented through a widespread diffusion of

knowledge indicating the dangers from the indiscriminate exposure of infants and young children to respiratory infections. These deaths should be diminished in number. Other phases of child hygiene, will be dealt with at length elsewhere.

COMMON COLDS

The term "common cold" represents a group of clinical entities characterized by symptoms of acute rhinitis, pharyngitis, laryngitis, tonsillitis, tracheitis or bronchitis or a combination of any of these. All of these conditions are communicable and are due to the invasion of certain specific microorganisms.

Incidence

No specific data have as yet been compiled to indicate the exact prevalence of colds. But during the winter months no minor disease is so great a cause of disability as is the common cold. The economic loss arising from this cause will in time be ascertained, when supervision of the health of the industrial workers is more general, and when other morbidity records are improved.

Etiology

Mechanical or chemical irritants may give rise to an inflammation of the mucous membrane of the upper portion of the respiratory tract, but the condition usually referred to as a cold is an acute communicable disease of microbic origin. In a recent series of papers, Williams, Nevin and Gurley have shown that the following species of bacteria were most commonly found in the secretions of the nasopharynx in cases of cold. Gram-positive cocci in 48 per cent of cases "Green-producing streptococci"—(Smith and Brown's alpha type of streptococcus) being much the most common of this group. Pneumococcus is next most prevalent and "hemolytic streptococci," (Smith and Brown's beta type), and then in order the indifferent streptococci, gamma type, and finally staphylococci, least prevalent. Gram-negative cocci were found in 19 per cent of cases, and among these M. flavus and M. siccus were most common, followed by members of the micrococcus catarrhalis group. Hemoglobinophilic bacilli were responsible for 17 per cent of cases, and among these were found both typical and atypical influenza bacilli.

Finally in 16 per cent of these cases other bacteria were found,

"large gram-negative bacilli," members of the bacillus mucosus capsulatus group, and certain other species not clearly defined. Reference is made in this interesting paper, to the earlier work of Kruse and Foster who claimed to have been able to demonstrate the presence of a filtrable virus, in secretions from the nasal cavities in colds. Williams, Nevin and Gurley were unable by using the filtrates of nasal washings from seven early cases of cold to infect forty-five volunteers, human beings, twenty of these being persons of less than thirty years of age.

The exact significance of other physical influences as predisposing causes of these conditions is not clearly understood. But the work of Leonard Hill, Mudd and Grant and others would suggest that certain factors which seriously disturb the normal blood supply of the nasal mucous membrane, produce a condition favorable for the invasion of bacteria. In other words, while there is no foundation for the older view that drafts, for example, cause colds, it is true that under certain circumstances, when the nasal mucous membranes are in a congested condition, exposure of a very limited area of the body to cold air may predispose to infection.

Modes of Transmission

Colds are conveyed either by direct transmission of bacteria from one individual to another through droplet infection, in coughing, sneezing, spitting, loud talking, etc., or, indirectly, when bacteria are conveyed to the nose and mouth of the susceptible persons on the hands, or through the use of common drinking-cups or other utensils or objects. Colds are especially likely to be communicated during the early stage of an attack. Probably all persons are susceptible at certain times and under certain circumstances, to these infections.

Prevention and Control

Cases of common cold, early in the attack should either go to bed, or if such is impossible, exercise every possible precaution to prevent the further spread of infection by limiting the spread of their nose and mouth secretions. Physicians should educate their patients in this matter and advise them first of all that colds are "catching," and secondly how the danger of infection may be lessened.

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CHAPTER VI

CEREBROSPINAL MENINGITIS, ANTERIOR POLIOMYELITIS, EPIDEMIC ENCEPHALITIS, TRACHOMA

CEREBROSPINAL MENINGITIS

Cerebrospinal meningitis is an acute communicable disease characterized by symptoms of an inflammation of the meninges of the brain and spinal cord. This disease may be due to one or more, of several specific microorganisms.

Incidence

Meningitis, all forms, was the assigned cause of death in 5,508 cases in the registration area of the United States in the year 1919; this is the equivalent of 6.5 per 100,000 of population, and 0.5 per cent of all deaths. In the same year in the Province of Ontario, there were 265 deaths from this cause in a total of 34,010. There is at present no means of ascertaining the prevalence of the disease, because notification is so incomplete. In nearly all communities the deaths due to meningitis exceed in number the cases of the diseases reported.

There is a definite seasonal incidence of epidemic meningitis. This clinical variety is present in sporadic form and occasionally becomes epidemic, especially in the winter and early spring. The prevalence of the disease is always very much influenced by the overcrowding of individuals in camps, barracks, or other type of habitation in which the cubic capacity allotted each person is insufficient, and in consequence of which, especially favorable conditions for the transfer of nasopharyngeal secretions prevail. Children and young adults are more susceptible to infection than are persons in other age groups. In a series of cases analyzed by the author the largest number of cases occurred between the ages of two and ten, and 80 per cent of the cases were twenty-five years of age or under.

Epidemics of meningococcus meningitis have been reported in

various parts of the world since 1805 when Vieusseux described the first outbreak among soldiers in Geneva. The disease has long been prevalent in sporadic form in Europe, Australasia, and America. Recent epidemics of considerable significance have been witnessed in the British Isles, notably in Belfast and Glasgow, and among troops in army camps between the years 1914 and 1918; in Italy, France, Germany, Austria, Greece and in North America in Massachusetts, New York and Texas. One attack of the disease does not confer a durable immunity.

Etiology

Cerebrospinal meningitis which occurs sporadically or in epidemics is due to the meningococcus. Considerable work has been done by Dopter, Gordon and various investigators at the Rockefeller Institute as a result of which, several types (3 or 4 in number) of meningococci (micrococcus intracellularis meningitiditis of Weichselbaum) are recognized. This is the disease entity which is also known as cerebrospinal fever, spotted fever, epidemic meningitis or meningococcus meningitis. In addition, however, sporadic cases of cerebrospinal meningitis may be due to B. tuberculosis, pneumococcus, streptococcus, B. influenzae or B. typhosus. Very occasionally certain other bacterial species may give rise to cases of meningitis. In a series of 137 cases carefully investigated in New York City in 1912-13 by the Bureau of Laboratories of the City Health Department the findings were as follows:

Tubercular meningitis	75 cases
Meningococcus meningitis	48 cases
Streptococcus meningitis	9 cases
Pneumococcus meningitis	3 cases
Influenzal meningitis	2 cases

In addition to the cases of the disease in which only one variety of microorganism is found, it occasionally happens that a mixed infection meningitis is observed. Cases of meningitis in which both meningococci and pneumococci were present have been reported by Netter and Salanier, Mathers and FitzGerald. The etiology in any case of meningitis can be determined only if a lumbar puncture is done and a careful bacteriological examination of the cerebrospinal fluid carried out. This should be done in every case; smears, cultures and if necessary animal inoculations made.

Modes of Transmission

The sources of infection in epidemic meningitis are (1) cases of the disease, (2) convalescent carriers, and (3) "healthy" carriers (that is persons who have been in contact with cases of the disease and have become infected). In all of these, the meningococci are present in the nasopharyngeal secretions. It is known that there are at all times a certain number of healthy carriers in the community, but these probably become greatly increased in number before an epidemic outbreak and also among those living in camp, barracks, etc., where there is much overcrowding. The importance of this factor has been carefully investigated by Glover for the Medical Research Council in England. It is stated that the carriers exceed the cases by 10 to 1 during an epidemic of meningococcus meningitis. The disease is peculiar to man, hence he is the only reservoir of infection.

The disease is usually transmitted *directly* by the transfer of nasopharyngeal secretions from infected persons to susceptible contacts in coughing, sneezing, etc., or, *indirectly* by the transfer of the germs on articles wet with nasopharyngeal secretions of the mouth or nose of infected persons. The meningococci may also be conveyed to the nose or mouth by the hands which have become soiled with nasopharyngeal secretions containing them. The incubation period of the disease is from two to ten days. In 70 per cent of a series of cases studied by the author the incubation period was seven days or less. It is important, however, in this connection to remember that a person apparently in good health may harbor meningococci in the nasopharynx for weeks or even months and then develop the disease. A case of the sort was reported in 1915 by Andrewes, Bulloch and Hewlett. Convalescents may also continue to carry the germs in the nasopharynx for weeks after they have recovered. However, in more than 90 per cent of cases they disappear from the nasopharynx by the fourteenth day of the disease.

Diagnosis

Just a word is necessary in reference to the question of diagnosis because the application of proper methods of prevention is conditioned in part on the early recognition of the disease. In every case in which there are symptoms of meningeal irritation, namely,

headache, vomiting, rigidity of the neck with retraction of the head, convulsions (especially in young children) rise of temperature, petechie, Kernig's sign, tache cérébrale, a lumbar puncture should be done, and the cerebrospinal fluid carefully examined. In about 75 per cent of cases of meningococcus meningitis the germs can be found in the cerebrospinal fluid by means of smears with Gram's stain (when gram-negative intracellular diplococci will be seen) or by culture on suitable media. Lumbar puncture nearly always in such cases reveals a turbid fluid, under pressure and containing a great increase in the number of cells (a polynucleosis) also a definite increase in the protein content, both albumin and globulin being increased in amount. At the same time the nasopharyngeal secretions, obtained on a swab, by means of a West tube should be examined for meningococci.

There are occasionally cases of meningitis, during the progress of which the connection between the subarachnoidal and intraventricular space (foramen of Magendie) becomes closed. These are cases of so-called "closed meningitis," in these the cerebrospinal fluid obtained by lumbar puncture may not show the presence of meningococci, while that obtained by puncturing the lateral ventricles will do so. These cases may give rise to difficulty both in diagnosis and in serum treatment.

Prevention and Control

Early diagnosis is of the utmost importance in the control of meningitis. If as a result of lumbar puncture and subsequent examination of the cerebrospinal fluid, the condition is found to be due to invasion of B. tuberculosis, pneumococci, streptococci or influenza bacilli the danger of the sporadic case giving rise to secondary cases is almost nil. If, however, meningococci are found in the cerebrospinal fluid, or if no meningococci can be seen but a very turbid fluid has been withdrawn, it may be assumed that the case is one of epidemic meningitis, and the necessary measures, to be presently detailed, carried out. Every case of meningitis, however, regardless of whether it is tubercular, pneumonococcus, streptococcus, influenzae or epidemic should at once be reported to the medical officer of health; compulsory notification of this disease is almost everywhere required. The patient should be isolated, indeed this should be done before the first lumbar puncture is made. If the home sur-

roundings are not suitable the patient should, if at all possible, be sent to hospital. If the patient is treated at home, the house will be placarded and the contacts quarantined by a representative of the local board of health. Nasopharyngeal swabs may be taken by means of the West tube, although this is not required when only an occasional sporadic case is under observation in a private house. Such swabbing, however, should certainly be carried out at the time of an epidemic and also among the contacts of a case which has occurred in an institution or camp or barracks. Those persons who are harboring true meningococci (that is strains agglutinable with anti-meningitis serum) should be kept under observation until 2 successive negative swabs are obtained from the nasopharynx at intervals of at least twenty-four hours.

Aseptic nursing should be carried out by those in attendance upon the patient, and all such should wear a gown and mask when in contact with the patient. Great care should be exercised to disinfect all nose and mouth secretions and bowel discharges. The bed linen and personal linen must be boiled or otherwise sterilized before taken from the room or ward in which the patient is. Separate dishes, etc., should be provided.

In barracks and camps, there should be adequate cubic space provided so that overcrowding may be avoided; this is especially desirable during the fall and winter months. Beds or cots should be so placed that a minimum of 600 cubic feet of air space at least is provided for every occupant, and, of course, there should be adequate ventilation in such living quarters. It is extremely important to prevent, during an epidemic, a large number of persons from becoming healthy carriers of meningococci. This can be accomplished only when nasopharyngeal swabs are taken from all contacts of known cases of the disease. The public require to be informed of this additional danger of promiscuous interchange of nasopharyngeal discharges through coughing, sneezing, spitting, etc.

The specific control of epidemic cerebrospinal meningitis by means of a meningococcus bacterial vaccine has been attempted but it has not been established that such a measure is effective. The use of a vaccine, therefore, must at present be regarded as being in the experimental stage, so far as active immunization is concerned. In the treatment of certain cases of the disease the

vaccine is sometimes used in combination with the specific anti-meningitis serum.

Specific Serum Treatment of Cases of Epidemic (Meningococcus) Meningitis

As a result of the early work of Jochmann and Park and of Flexner and his associates at the Rockefeller Institute the serum treatment of meningococcus meningitis has been established as a method of great value in reducing the mortality due to epidemic meningitis. This method of serum treatment is really specific and little or no benefit is likely to accrue from its use in cases of meningitis due to other species of microorganisms. While isolated case reports have been published indicating that in occasional cases serum has apparently been of value in the treatment of other types of meningitis, it is doubtful whether drainage of the cerbrospinal fluid in such cases and nonspecific serum treatment would not have accomplished the same result. The outlook in all cases of meningitis due to other germs than meningococci is very grave, the mortality running from 95 to 100 per cent. According to Kolmer the gross mortality in cases of meningococcus meningitis not treated with the specific serum varies from 70 to 90 per cent, while among the cases treated with serum the mortality is about 30 per cent. Table XXXIII is given by Kolmer to indicate the significance of early diagnosis and immediate use of serum.

TABLE XXXIII

MORTALITY ACCORDING TO THE PERIOD OF INJECTION OF SERUM

TIME OF INJECTION	MORTALITY PER CENT.			
	Flexner 1294 Cases	Dopter 402 Cases	Netter and Debre, 99 Cases	Sophian 161 Cases
First to Third Day	18.1	8.2	20.9	9.0
Fourth to Seventh Day	27.2	14.4	33.3	14.9
Later than Seventh Day	36.5	24.1	26.0	22.6
Average Mortality	30.8	16.44	28.0	15.5

Gordon has recommended the use of a specific antimeningitis serum prepared by immunizing horses with a single type of meningococcus. This is the so-called mono-typical serum. The results of the use of such a serum in a series of cases has been reported by Gordon and Hine. Flexner and others still recommend the use of a polyvalent

serum, that is, one prepared by the immunization of horses with a variety of types of meningococci.

The following directions of the use of antimeningitis serum are those distributed with the serum prepared in the Connaught Antitoxin Laboratories, in the University of Toronto:

Antimeningitis serum is a specific immune serum of therapeutic value only in meningococcus meningitis. It is administered subdurally and intravenously.

Perform lumbar puncture under aseptic precautions in the third or fourth space, having the patient lying on the side with the back arched so that there will be the greatest possible distance between the spines of the vertebrae. Find the notch nearest the line connecting the crests of the ilia. Introduce the needle in the middle and push forward and a little upward. The distance the needle goes in depends upon the age of the patient and the muscular development. It varies from ½ to 3 inches. Allow the cerebrospinal fluid to flow out until the pressure is so reduced that only 3 or 4 drops come per minute. If the fluid is cloudy, inject the serum immediately.

Apparatus for Injecting Serum

A syringe may be used, but a funnel and tube arrangement allowing it to run in by gravity is much better. The barrel of an ordinary syringe may be used as a funnel. The rubber tubing should be ⅛ to ¼ of an inch in diameter and long enough so that the funnel can be raised 12 to 15 inches. Serum is ordinarily supplied in vials of 20 c.c. quantity. A special package is also obtainable consisting of a vial containing 20 c.c. of serum, and rubber tubing, spinal needle, and 2 stylets. Full directions for using this outfit are enclosed with each package.

Dose

In general, the average intraspinal dose for an adult is 20 to 40 c.c., and for infants and children 3 to 20 c.c. The amount depends as much upon the quantity of cerebrospinal fluid drawn as upon the age. An infant will frequently stand 10 to 15 c.c. without difficulty. The dose should usually be at least 5 to 10 c.c. less than the amount of cerebrospinal fluid withdrawn. Where possible, further injections are made only after bacteriological examination has

shown the cause to be the meningococcus. The antimeningitis serum does no harm in meningitis due to other organisms.

In very severe cases it is best to inject the serum every twelve hours until there is improvement. In moderate and mild cases, it should be repeated each day for the first four days. Further administration depends upon the patient's general condition and the bacteriological examination of the fluid. Usually 4 to 6 injections are necessary, but as many as 15 or more may have to be employed.

Important Points in Injecting Serum

The serum is warmed to body temperature and injected very slowly under the least possible pressure. Where serum apparently runs in freely after a dry tap, it is advisable to proceed very slowly and to watch the patient carefully for the slightest change in pulse and respiration. In cases with very thick exudate which will not flow through the needle, gentle suction with a syringe may be tried. If that fails, a little serum injected will sometimes start the flow. During or immediately after the injection of serum the respiration may entirely cease or the pulse may become rapid and thready. Such an occurrence, while alarming, is not necessarily serious and is best treated by immediate withdrawal of some of the serum if the needle is still in place. If the needle has been withdrawn, or if after some of the serum is removed, the symptoms do not ameliorate, artificial respiration should be resorted to for the respiratory condition and adrenalin or other stimulants given hypodermically for the heart.

ANTERIOR POLIOMYELITIS

An acute communicable disease, sporadic cases of which are observed in temperate climates at all times, and epidemics every few years.

Incidence

In 1910 in the registration area of the United States 1,459 deaths from this disease were recorded—a rate of 2.7 per 100,000 of population. As a cause of death in nonepidemic years the disease is not of the first importance. The prevalence of poliomyelitis when only occasional sporadic cases occur, is difficult to ascertain. In the

Province of Ontario in 1919 there were reported only 49 cases and 8 deaths, in a total of 17,113 cases of communicable diseases. During 1920, in the same Province there were 37 cases (in 61,074 cases of communicable diseases of all kinds reported) and 14 deaths notified. In epidemic years, however, both as a cause of death and of permanent disability, anterior poliomyelitis assumes great significance. Since 1881 when an epidemic was described by Bergenholtz, the Scandinavian countries have witnessed many severe outbreaks. As a result of this, Wickman in his monograph, and later Kling and Pettersson, directed attention to the factors which seemed to influence the spread of the condition and suggested that it was most probably a communicable disease. This was established experimentally in 1909 by Landsteiner and Popper. Wickmann in 1905-1906 was the first to describe the mild nonparalytic type of cases of the disease. A number of important points in regard to incidence have been reported by Frost and by Hermann. In a paper by Hermann the frequency of anterior poliomyelitis as compared with other important communicable diseases first, during a 5 year period, and second, during the first ten months of 1916 (an epidemic year) is shown in Fig. 25.

TABLE XXXIV

MORBIDITY IN THE EPIDEMICS OF 1907 AND 1916 IN NEW YORK CITY*

BOROUGH	POPULATION 1916	MORBIDITY PER 10,000	UNDER 5 YEARS PER 10,000	PERCENTAGE OVER 9 YEARS	MORBIDITY PER 10,000 IN 1907
Manhattan	2,634,223	9.5	6.43	7.69	1.61
Brooklyn	1,928,432	23.4	15.47	5.15	0.83
Bronx	575,877	10.9	6.78	5.39	....
Queens	366,426	30.6	16.64	7.62	....
Richmond	97,883	29.1	22.30	5.78	....

*Number of Cases, 1916, 8,927; deaths 2,343; death rate 26.24 per cent.

In Table XXXIV and Fig. 26 the age incidence in the 1916 epidemic in the City of New York (when it was epidemic also in various parts of North America) is also shown.

The 1916 epidemic in New York reached its peak in the late summer. Beginning in June, the largest number of cases were reported in August and September, and it ended in October. This is the characteristic seasonal incidence of epidemics which have been observed in North America. In Scandinavian countries the epidem-

ics have extended into winter months. The characteristic age incidence is well illustrated in the above chart. No age, however, is exempt. The disease has prevailed in widespread epidemics in rural communities. Such an outbreak occurred in the State of Iowa in 1910. In all, nearly 100 outbreaks have been reported in

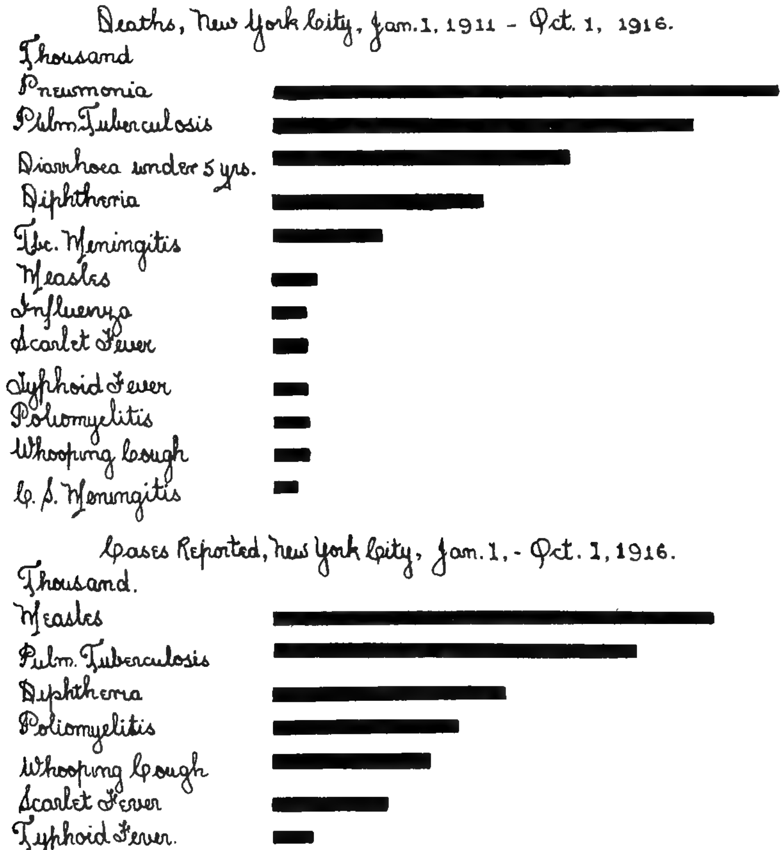
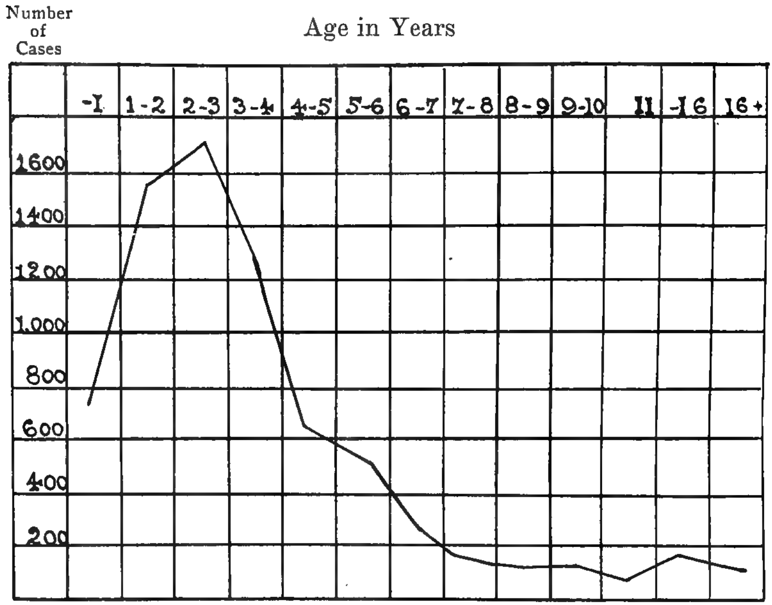


Fig. 25.

Norway, Sweden, Austria, Germany, Holland, England, Spain, United States, Canada and Cuba since 1880. Of these, the outbreak in 1916, in the United States, especially in the City of New York, was the most serious yet recorded. Social and hygienic conditions do not appear to influence the prevalence of the disease (Rosenau).



Age Incidence of Poliomyelitis, New York City, 1916.

Fig. 26.

Etiology

The increased frequency in the appearance of epidemics of the disease led to much experimental effort to elucidate the important features of the disease. As a result, in 1909 Landsteiner and Popper announced that they had succeeded in transmitting the disease to monkeys. An emulsion of the spinal cord of a fatal case of the disease in a child was injected into monkeys, and produced in them symptoms of the disease. Flexner and Lewis, later in the same year, reported similar results. Flexner and Lewis were able also to transmit the disease from monkey to monkey. The virus is a very small ultramicroscopic filtrable organism. Flexner and Noguchi in 1913 succeeded in obtaining cultures of small globoid bodies which they believe to be the cause of the disease. The virus is present in the brain and spinal cord, in the blood and cerebrospinal fluid, in tonsils and the mucous membrane of the nose and pharynx, in the mesenteric, axillary, and inguinal glands, in mouth and nose secre-

tions, and in intestinal discharges. The virus is not especially resistant; heating at 50° C. for thirty minutes will destroy it, as will weak solutions of antiseptics such as 1 in 500 potassium permanganate solution. It withstands cold and drying very well, and in pure glycerine, a piece of spinal cord from a fatal case of the disease will retain its virulence for months.

Modes of Transmission

The disease is conveyed (1) directly in the nasopharyngeal secretions or intestinal discharges from (a) cases of the disease, (b) convalescents or (c) healthy carriers, or by the hands wet with the secretions; or (2) indirectly to susceptible contacts, by articles soiled with mouth or nose secretions, or intestinal discharges containing the virus. It is possible that the virus may also be transferred in, or on food, including milk. The idea has been advanced that insect transmission may explain the conveyance of infection, this view at present has few adherents. Finally it has been suggested dust, containing the virus, may be a means of transfer of infection. This, too, seems at the present time not to be a factor of importance. Frank cases of the disease are probably not so important sources of infection as the so-called *"abortive cases"* (those having the disease in a mild form, often without paralysis following the attack) or *healthy carriers.* Anderson and Frost by means of an immunity reaction (the neutralization of the virus with the serum of immune convalescents) in anterior poliomyelitis established the fact that these abortive cases really had suffered from a definite attack of the disease. Such cases are often not recognized. The blood of convalescents contains immune bodies, or protective substances, capable of inactivating the virus of the disease (first demonstrated by Levaditi and Netter, and Flexner and Lewis). As a result of this, one attack of the disease usually confers a permanent immunity.

The virus when conveyed to the susceptible contact is believed to enter the body through the nose or mouth and then penetrate the nasopharyngeal mucosa. The incubation period of the disease is from three to ten days and, most commonly, six days (Park). The person suffering from the disease does not, as a rule, retain the virus for a period of more than three weeks after the onset of symp-

toms, though it may persist for six weeks. Osgood and Lucas demonstrated the fact that the virus might remain in the nasal mucous membrane of an experimentally inoculated monkey for as long as 5½ months. Kling, Pettersson, and Wernstedt and Flexner and Clark have observed in human convalescents that the virus may persist in the mouth or nose secretions for a considerable period of time. The attack rate of the disease is very low; that is the number of susceptibles among those exposed to infection is much less than in many other communicable diseases. It is less than $\frac{1}{15}$ that of scarlet fever, according to Frost.

Diagnosis

The early recognition of the disease is a factor of great importance in its control. The symptoms are those of an acute generalized infection. "It is now generally conceded that poliomyelitis virus enters the human body by way of the upper respiratory passages and in particular through the nasopharyngeal mucous membrane.

"Once within this membrane the virus may pass through the lymphatic channels surrounding the filaments of the olfactory nerve to the leptomeninges where it reaches the cerebrospinal fluid or it may first enter the blood and be conducted to the central nervous organs by the general circulation." (Flexner and Amoss.)

After a brief period, there is a sudden explosive onset with vomiting, rise of temperature, evidence of meningeal irritation, sometimes definite focal symptoms, as, for example, difficulty in swallowing. In children, convulsions or delirium may occur. Suddenly there appear asymmetrical, bilateral paralyses. There may be pain in the muscles before the paralysis appears. In some cases there are no definite paralyses, simply muscular weakness. In the abortive cases neither paralysis nor weakness may be detected. Such cases can be identified by the history of exposure, initial symptoms, etc., and may be confirmed by means of the immunity reaction.

In addition to the clinical symptoms, the cerebrospinal fluid should be examined in all suspected cases. If lumbar puncture is performed at once and the cerebrospinal fluid examined, much valuable time may be saved. In certain cases this may mean saving the life of the patient, as well as controlling a definite source of infection.

Patients, especially little children, with a history of a sudden

onset of fever, vomiting, and perhaps pain in the back of the neck, and in the back, and vague symptoms of meningeal irritation, should always be regarded with suspicion, and focal symptoms, such as difficulty in swallowing, or disturbance in special senses suggest that the patient be isolated at once and lumbar puncture performed.

The cerebrospinal fluid is as a rule increased in amount, under slight pressure, and occasionally it may be very slightly opalescent; but as a rule it is clear, though occasionally flakes of fibrin are seen. The cells are increased in number and the globulin content is increased in amount. The cells run from 10 to 100 per c.mm. usually. A count of 1,000 per c.mm. will be observed only rarely. "During the first few days, polymorphonuclear cells, and cells with irregular nuclei may be numerous but after the first week the increase is due almost entirely to cells of the lymphocytic type." (Francis Fraser.) In some cases the increase in cell content is due chiefly to an increase of mononuclear leucocytes.

Prevention and Control

Emphasis has already been laid upon the necessity of regarding with suspicion children who show vague meningeal symptoms, etc., and especially is this true when the disease is epidemic. Cases should at once be isolated and reported to the local board of health. Other children contacts should be excluded from school and kept under careful observation for a period of 2 weeks. Great care should be insisted upon in the disposal of mouth and nose secretions and intestinal discharges. All such should be burned, or sterilized by moist heat, or disinfected with 1-20 carbolic acid solution. If the patient is treated at home, separate dishes, etc., should be provided, and unused food should be destroyed. Concurrent disinfection and thorough cleansing of the sick room should be carried out at the termination of the illness. The representative of the local health department will placard the premises where cases of the disease are being treated, and all contacts, with the exception of breadwinners will be quarantined. Such should, of course, have no contact whatever with the patient, and should, by preference, live elsewhere if at all possible during the period of illness of the sick member of the family.

The after-care of cases of anterior poliomyelitis, especially in

communities where the disease has been epidemic, is a matter of much importance and should engage the attention of the local public health authorities. Vigorous action should be taken, through the organization of an orthopedic and after-care service, to reduce to a minimum, the volume of disability resulting from an epidemic of anterior poliomyelitis.

Serum Treatment of Anterior Poliomyelitis

While there is no method for the specific prevention of this disease; as a result of the work of Flexner and Lewis, Römer and Joseph, and Levaditi and Netter, a method of serum treatment has been evolved which is of much value in certain cases. This is based on the observation that human beings and monkeys that have recovered from an attack of the disease show in the blood, the presence of certain immune or protective substances. These immune substances have the power of neutralizing the virus of the disease, as has already been indicated.

In the treatment of human cases, serum obtained from convalescents or recovered cases of poliomyelitis is injected intraspinally, after withdrawal of cerebrospinal fluid by lumbar puncture. Doses of from 5 to 20 c.c. of serum are given, and the injection may require repetition once, or more often, at twelve- to twenty-four-hour intervals, according to the clinical condition of the patient. The serum need not be inactivated. Serum from patients who have recovered months before may still contain the immune substances. Of course, the more recently recovered patients are probably most suitable as sources of the serum.

EPIDEMIC ENCEPHALITIS (ENCEPHALITIS LETHARGICA, NONA)

"An epidemic syndrome characterized in most instances by a gradual onset with headache, vertigo, disturbances of vision, ocular palsies, changes in speech, dysphagia, marked asthenia, fever (usually of a low grade), obstinate constipation, incontinence of urine, a peculiar mask-like expression of the face, and a state of lethargy which gradually develops in the majority of the recognized cases into a coma that is more or less profound." (H. F. Smith.) The

name "Schlafkrankheit" (sleeping sickness) was first applied to the disease by Camerarius in 1712.

Incidence

This disease entity, if such it is, has been definitely recognized since about 1712. The early history of the disease indicates that its appearance in epidemic form has usually followed a pandemic visitation of influenza. During the past twenty-five years it has been observed in various countries in Europe, in Africa, in the British Isles, and in North America. An epidemic occurred in 1917 in Vienna; in 1918 in France and Great Britain; in the United States and Mexico, in 1918 and 1919; and, in Canada, in 1919 and 1920. In the United States, between September, 1918, and May, 1919, the disease was observed in 21 states, 255 cases having been reported during that time. The most extensive outbreak in Canada occurred in Winnipeg in 1919. The largest number of cases in the United States were reported in March, 1919. The disease seems to have a definite seasonal incidence, being most prevalent during the winter months, January, February, and March.

Age-Incidence

In a series of 181 cases, 85 per cent of cases were in persons over five years of age, and 58 per cent in individuals over twenty years of age, whereas in anterior poliomyelitis less than 4 per cent of cases occur in persons over twenty years of age. A comparison of the age distribution of cases of epidemic encephalitis, and influenza shows a marked difference in the percentage of the total cases distributed in the various age groups. The age group forty to fifty-nine years shows the highest incidence of any age group for epidemic encephalitis. The disease is apparently somewhat more prevalent among males than females.

Etiology

The cause of the condition is at present unknown. Von Weisner claims that the etiological agent is a diplostreptococcus.

Mode of Transmission

The way in which the disease is transmitted from one individual to another is not known at this time. The incubation period is also unknown.

Diagnosis

The disease presents a fairly characteristic clinical picture. The onset is usually gradual. The most common symptom is paralysis, in more than 90 per cent of the cases, and the third, fourth and sixth cranial nerves are most often involved. Fever is the next most common symptom, the temperature varying between 100° F. and 102° F. Then, in order, the following symptoms are most frequently present, constipation, coma, ptosis, asthenia, headache, lassitude, aphasia, diplopia, tremors, strabismus, vertigo, blurred vision, facial paralysis, muscular rigidity, dysphagia, Babinski's sign, incontinence of urine, etc.

Smith states that two of the most important procedures in the diagnosis are laboratory examinations of the cerebrospinal fluid, and the blood. Lumbar puncture should be done in every suspected case. The fluid is most frequently not under increased pressure. It is sterile, appears normal macroscopically, shows a slight increase in protein content in about 50 per cent of cases and a *normal reduction of Fehling's solution* in 100 per cent of cases. This is a valuable point in the differential diagnosis of encephalitis and tuberculous meningitis. In 65 per cent of cases there was a slight, moderate or marked increase in the cell count of the fluid. In 17, uncomplicated cases in a series of 43, the white blood cell count was above 10,000 per c.mm.

Animal inoculations carried out in the Hygienic Laboratory of the United States Public Health Service yielded only negative results.

Prevention and Control

It is at present impossible to formulate any rules for the control of epidemic encephalitis. Isolation would seem to be desirable, and the responsible public health authority should be notified of the occurrence of the case. The disease does not seem to be highly communicable. Among 900 persons exposed to infection in the immediate families of cases reported in the United States, no secondary case occurred so far as could be determined. The death rate in the series of cases reported by Smith was 29 per cent.

An excellent summary of the present knowledge of the condition appeared recently, in the weekly Public Health Reports of the United States Public Health Service, by H. F. Smith.

Epidemic Hiccough

It is possible that the condition recently described by Sicard and Paraf, and by Netter, in the French literature is a variety of epidemic encephalitis. This condition is characterized by a sudden onset with a slight rise in temperature, and the appearance of rhythmic crises of hiccough, which last from one-half to one and one-half hours. The attacks are repeated about every two hours. During the attack the spasms occur about every ten to twelve minutes. Persons suffering from this condition appear otherwise to be in good health.

TRACHOMA

Trachoma is a chronic inflammatory condition of the conjunctival membranes of the eyelids, highly communicable, and of a very serious character.

Incidence

The disease (if it is a separate clinical entity) is very widespread in certain parts of Europe, and in communities in the United States and Canada, which are largely settled by immigrants from Europe. Trachoma is especially prevalent where habits of personal hygiene are undesirable and where general unsanitary conditions exist. In both the United States and Canada strenuous efforts are made to prevent the entrance into these countries of persons suffering from this condition. A rigid examination is carried out at the port of entry by officers of the quarantine service.

Etiology

Decided differences of opinion obtain as to the etiological agent of trachoma. Undoubtedly it is due to a microorganism. The Koch-Week's bacillus is believed by many to be the cause. Others maintain that it is due to a protozoan parasite.

Mode of Transmission

The sources of infection are the secretions and discharges from the conjunctivae of persons suffering from the disease. The infectious agent is present in such discharges, and is transmitted by direct contact by the hands, etc., or indirectly, by articles soiled

with these discharges and secretions being brought into contact with the eyelids of other persons. The incubation period of the disease is not known.

Trachoma is highly communicable. Persons are able to convey the disease to others as long as lesions of the conjunctivae and adjacent mucous membranes persist.

Prevention and Control

Early recognition of the disease, immediate notification, and concurrent disinfection of the infectious discharges and secretions, are important measures in the control of the disease. Education of those exposed to infection, as to how to avoid infection, should be carried on.

Thorough and careful inspection of incoming immigrants, and the examination of school children, especially among the foreign born population, is most valuable. The absolute prohibition of the use of common roller-towels, etc., is also essential.

As a public health measure the treatment of known cases of the disease should be provided. This may be done in the home or in special dispensaries. A trachoma treatment service of this sort is conducted by the Bureau of Public Health in the Province of Saskatchewan.

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CHAPTER VII

COMMUNICABLE DISEASES TRANSMITTED BY THE CONTAMINATION OF FOOD OR WATER WITH CERTAIN SPECIES OF BACTERIA

Diseases of this group can be contracted only when the germs find their way into the gastrointestinal tract. With the single exception of hookworm disease, the causative microorganisms must be ingested before they can give rise to the disease. In all, they are given off in the excreta, feces, or urine, or both. From such excreta they are conveyed by *water, food, fingers, or flies* to susceptible human beings. Man, only, is naturally susceptible to these diseases, hence there is only one reservoir of infection, and that is man himself. These diseases are *typhoid fever, paratyphoid fever, dysentery,* (bacillary and amebic) *Asiatic cholera, diarrhea* and *enteritis in infants* and young children, and *hookworm disease.*

TYPHOID FEVER

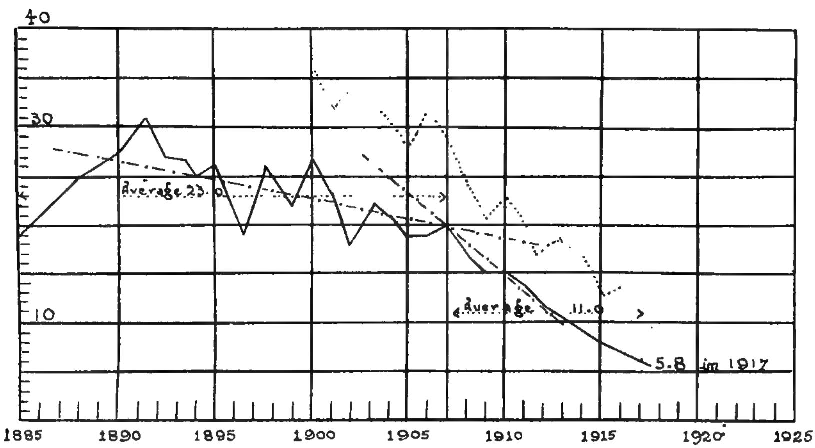
An acute communicable disease present in endemic form in communities in nearly all parts of the world, occasionally epidemic. The limitation of epidemic incidence is due entirely to the characteristic mode of transmission of the disease.

Incidence

Typhoid fever, while still very prevalent in certain parts of the world, is literally a vanishing disease. It arose apparently in the nineteenth century, and it bids fair to disappear in the twentieth, if the present rate of progress is maintained. As Sedgwick has pointed out, "typhoid fever is a discovery of modern civilization. When Queen Victoria was born in 1819, typhoid fever was unknown. When she was ten years old it was just beginning to be recognized by a few pioneers as something different from typhus fever with which it had hitherto been everywhere confounded. When she ascended the throne in 1837 it was still generally unrecognized even

by progressive physicians." And this, despite the fact that Louis, in 1829 had clearly differentiated these diseases clinically. It was not until 1873, that Budd, an English physician, established the fact that typhoid fever was (as it was then expressed) "contagious."

DECLINING TYPHOID FEVER DEATH RATE IN NEW YORK STATE, SINCE ESTABLISHMENT OF ACTIVE SUPERVISION OF WATER SUPPLIES BY DIVISION OF SANITARY ENGINEERING (1917)



Solid Line = New York Typhoid Death-Rate.
Dotted Line = Typhoid Death-Rate in (expanding) U.S. Registration Area

Fig. 27.

In 1869, in London, the mortality, per million of population, was 350. Since that time it has been declining in the following remarkable fashion:

1879	– 220	per million
1889	– 125	" "
1899	– 175	" "
1909	– 70	" "
1919	– 20	" "

The morbidity rate in England and Wales has fallen from 38 in 1911, to 10 in 1919; and in London, for the same year, it was 8.

In the registration area of the United States, in the year 1919, there were 7,860 deaths (0.7 per cent of all deaths) from typhoid fever. This is a rate of 9.2 per 100,000 of population. For a number

DEATHS FROM TYPHOID FEVER, ONTARIO. TOTAL DEATHS

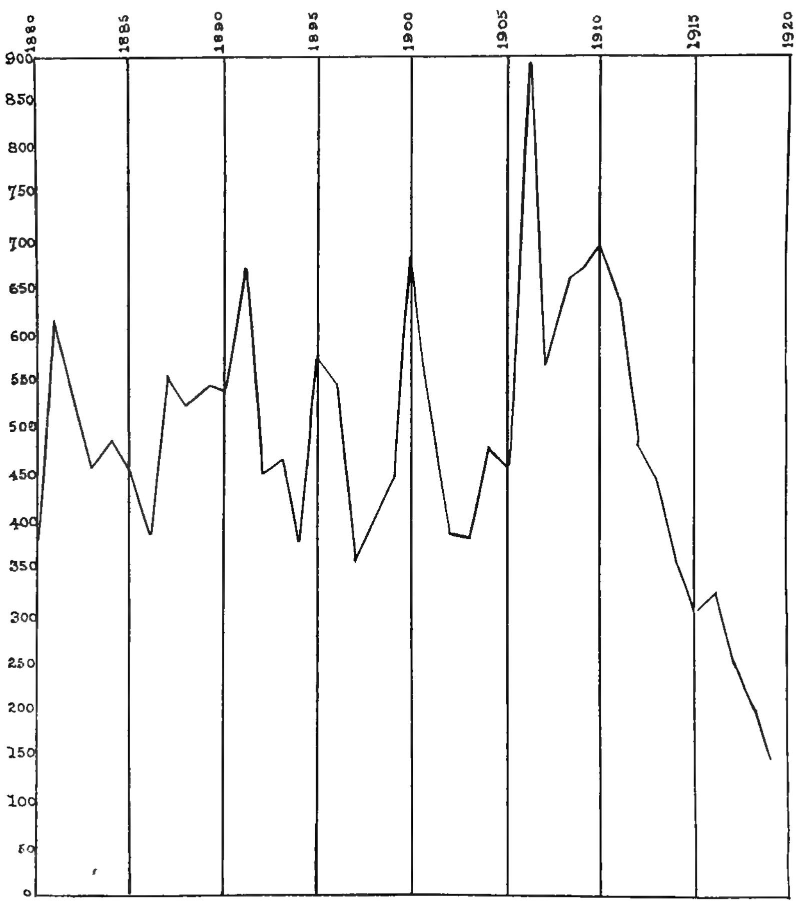


Fig. 28.

of years past the *Journal of the American Medical Association* has presented an annual survey of typhoid fever mortalities in cities of the United States of more than 100,000 population. Tables XXXV, XXXVI and XXXVII give summaries for the year 1920.

TABLE XXXV

DEATH RATES FROM TYPHOID IN CITIES OF GROUP I (MORE THAN 500,000 POPULATION)

Deaths from Typhoid per 100,000 Population

	1920	1919	AVERAGE 1916-1920	AVERAGE 1911-1915	AVERAGE 1906-1910
Chicago	1.1	1.2	2.4	8.2	15.8
Boston	1.5	2.2	2.5	8.0	16.0
New York	2.4	2.0	3.2	8.0	13.5
Los Angeles	2.6	4.7	3.6	10.7	19.0
St. Louis	2.7	5.8	6.5	12.1	14.7
Pittsburgh	2.7	6.2	7.7	15.9	65.0
San Francisco	3.1	3.3	4.6	13.6	27.3
Cleveland	3.2	2.4	4.0	10.0	15.7
Philadelphia	3.3	4.4	4.9	11.2	41.7
Baltimore	4.7	8.9	11.8	23.7	35.1
Detroit	5.1	5.3	10.6	18.1	21.1
Buffalo	5.1	7.0	8.1	15.4	22.8

TABLE XXXVI

DEATH RATES FROM TYPHOID IN CITIES OF GROUP II (FROM 300,000 TO 500,000 POPULATION)

Deaths from Typhoid per 100,000 Population.

	1920	1919	AVERAGE 1916-1920	AVERAGE 1911-1915	AVERAGE 1906-1910
Newark, N. J.	1.9	2.1	3.3	6.8	14.6
Seattle	1.9	2.3	2.9	5.7	25.2
Milwaukee	2.2	3.5	6.5	13.6	27.0
Minneapolis	2.6	3.1	5.0	10.6	32.1
Cincinnati	3.0	2.6	3.4	7.8	30.1
Indianapolis	3.8	4.7	10.3	20.5	30.4
Washington	6.5	3.7	9.5	17.2	36.7
New Orleans	7.4	13.7	17.5	20.9	35.6
Kansas City, Mo.	7.6	11.2	10.6	16.2	35.6

The fall in typhoid mortality in the State of New York and Province of Ontario is shown graphically in the accompanying series of diagrams: Fig. 27 from *Health Bulletin New York State Department of Health.* Figs. 28, 29, and 30 to illustrate Ontario experience.

In the Province of Ontario the distribution of typhoid mortalities in cities, towns and rural municipalities is shown in Table XXXVIII taken from the Report of the Provincial Board of Health for 1918.

It is probably still true, as emphasized by Osler a number of years ago, that the prevalence of typhoid fever in any community is one index of the civilization of that community. The decline in

DEATHS FROM TYPHOID FEVER—ONTARIO

Ratio per 100,000 of Population.

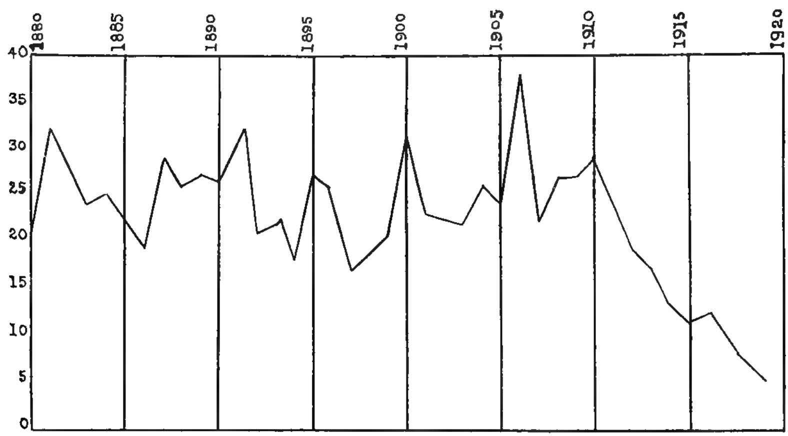


Fig. 29.

DEATHS FROM TYPHOID FEVER—ONTARIO
PERCENTAGE OF TOTAL DEATHS

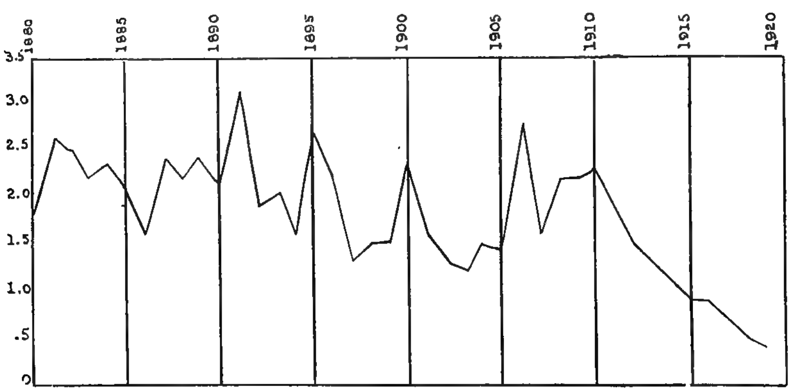


Fig. 30.

morbidity has often not quite kept pace with the decline in mortality as is shown in Table XXXIX.

In communities where intensive antityphoid measures have been carried out, epidemics are no longer observed, and the endemic prevalence is greatly lessened. When this is reduced to a point

TABLE XXXVII

TOTAL AVERAGE TYPHOID FEVER DEATH RATE (1910-1920)*

YEAR	TOTAL POPULATION (57 CITIES) ESTIMATED BY U. S. CENSUS BUREAU METHODS	TYPHOID DEATHS	TYPHOID DEATH RATE PER 100,000
1910	20,996,035	4,114	19.59
1911	21,545,014	3,391	15.74
1912	22,093,993	2,775	12.56
1913	22,642,972	2,892	12.77
1914	23,191,951	2,408	10.38
1915	23,740,930	2,068	8.71
1916	24,205,359	1,842	7.61
1917	24,740,068	1,647	6.65
1918	24,971,278	1,557	6.23
1919	25,526,186	987	3.87
1920	26,154,013	921	3.52

*Eleven cities are omitted from this summary because data for the full period are not available.

TABLE XXXVIII

ANNUAL DEATH RATE FROM TYPHOID FEVER PER 100,000 OF POPULATION. PERIOD 1908-1918

RATE FOR	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908
County	5.09	6.58	8.1	9.45	10.0	13.3	10.9	16.1	22.0	25.1	20.5
City	9.6	7.5	12.1	9.43	12.4	17.3	27.7	35.8	51.5	34.3	37.8
Towns	17.2	31.4	52.2	38.0	47.4	46.0	47.0	62.3	56.4	67.7	107.3
Average for Prov.	7.52	8.4	12.5	10.7	13.5	16.7	18.7	25.3	31.5	29.9	29.7

TABLE XXXIX

PROVINCE OF ONTARIO

YEAR	NO. OF CASES REPORTED	DEATH RATE PER 100,000 OF POPULATION
1910	2,192	31.5
1911	2,477	25.3
1912	2,569	18.7
1913	1,519	16.7
1914	1,060	13.5
1915	930	10.7
1916	1,225	12.05
1917	825	8.4
1918	797	7.52
1919	492	5.2

below which it is difficult, in the present state of public education, to lower the incidence-rate, the cases of the disease which still continue to arise, constitute what is called "residual typhoid." Administrative control of carriers, and more general antityphoid

inoculation, combined with other methods at present applied, would probably materially affect this remaining volume of the disease. The time, however, does not seem quite ripe for this further advance.

Cases of endemic or residual typhoid fever may occur at any season of the year; there is often a slight increase in such endemic typhoid, however, in the late summer or early fall. Epidemics, especially water-borne, usually have a very characteristic and quite constant seasonal incidence. They are most frequent in late winter and early spring. The disease is more prevalent in persons between the ages of 15 and 30, than at any other time of life. Cases in childhood are not uncommon, but among those of advanced age the disease is quite unusual.

Etiology

The disease is caused by a specific microorganism, the Bacillus typhosus of Eberth. This was established in 1880.

Modes of Transmission

The first important fact to be borne in mind is that human beings only, act as sources of infection. The germs of the disease do not live for any length of time outside the body. They quickly die in soil, and only live for a short time in water, but for a somewhat longer time in milk, or in food which acts as a culture medium. However, neither milk nor foods could be contaminated were it not for human beings who harbor the typhoid bacilli. The incubation period of the disease is usually 10 to 14 days, and occasionally shorter, as, for example, in milk-borne epidemics where, because of massive infection, it may be as short as eight days. The bacilli are found in the blood stream very early in typhoid fever; in about 90 per cent of cases during the first week of the disease. As a result, the germs may be found in the feces as early as the sixth or seventh day. If repeated bacteriological examinations are made of the stools of typhoid patients, 75 per cent of cases will yield B. typhosus between the second and fourth week of the disease. As a rule they are not found in the urine before the end of the second week of the disease. They are then found in 25 to 50 per cent of cases. The bacilli are not found in the blood late in the disease, and it is interesting that the disappearance of the microorganisms from the circulation is coincident with the

appearance in considerable concentration of antibodies such as agglutinins. Typhoid fever is probably not a true septicemia. The bacilli are thrown into the blood stream, in enormous numbers during the first week of the disease, but they grow and multiply in the lymphoid tissue, and their stay in the blood stream is quite temporary. These facts in regard to the disease suggest certain points which are of importance in connection with the control of typhoid fever—which will be discussed later.

Whatever be the exact medium in which typhoid bacilli are conveyed to man, he can be infected only by ingestion, that is, by swallowing the germs. This he may do in water or in food (including milk). The former may be polluted with human excreta containing typhoid bacilli; the latter may be contaminated by the fingers of persons of unclean habits who are excreting typhoid bacilli in feces or urine; that is by carriers, who may be so-called healthy carriers or convalescent carriers. Finally food may be contaminated by flies that have had access to typhoid excreta and mechanically conveyed the germs on their feet to food. The carriers of B. typhosus may be those who have but recently recovered from an attack of the disease, in which case they are known as convalescent carriers or they may be persons who many years before had an attack of typhoid, and as a result have continued for years, constantly or intermittently, to excrete typhoid bacilli in the feces or urine or both. These carriers are in large part responsible for the endemic occurrence of the disease. The extent of the carrier menace in typhoid will be appreciated when it is understood that between 1 and 2 per cent of all cases of the disease become healthy carriers. Fortunately many of these excrete the germs only intermittently and possibly less than 1 per cent become chronic carriers, though exact information in reference to this is not yet available. The intermittent healthy carriers are a very great danger especially if they find employment in dairies, restaurants or as cooks in private families.

In addition to the residual typhoid, which may in large part be due to the contamination of food by carriers, localized epidemics of the disease may also occur in communities where little or no supervision of water, milk or other food supplies is undertaken. When these epidemics develop, their origin can usually be traced to contamination of *water*, *milk*, or *food* on a large scale. When polluted

water is the source of infection, it is known as a *water-borne* epidemic; when milk, a *milk-borne* epidemic; when contamination of food supplies by flies is responsible, a *fly-borne* epidemic; and, finally, if a carrier has contaminated food it is known as a *carrier outbreak* of the disease. Each of these types of epidemic has certain characteristics by which it can usually be recognized. *Water-borne typhoid epidemics have the following characteristics:*

1. They are most likely to occur in the late fall, winter, or early spring, when the water is cold, and when a rise in the level of the water in streams, etc., may result in excreta containing typhoid bacilli being washed into such streams, and thence carried to the users of the water supplies.

2. These outbreaks of water-borne typhoid have a sudden explosive onset, as a rule. There is a sharp increase in the number of cases, which quickly reaches a peak, and then follows a sharp decline, if the polluted water supply is cut off or disinfected.

3. The distribution of cases, of the disease, is general throughout the whole area supplied with water from the polluted source. (Persons living in, or adjacent to, the community, but using water supplies from other sources, are free from infection.)

4. There is a large percentage of cases among adults. These are general observations, and if, to them, is added the epidemiological evidence which may be obtained by a sanitary survey of the sources of the suspected water supply, combined with a laboratory examination of the water, the following additional points are usually elicited:

5. A careful examination of the source from which the water is obtained will indicate that pollution of the water with sewage, or with excrement from privies, etc., is probably being permitted at the source, or at some point in the collecting or distributing system.

6. The laboratory examination of samples of water from the suspected source, as a result of bacteriological and chemical analysis, will reveal the presence in the water of intestinal bacteria. B. coli can usually be found even in very small amounts of such water samples, and this is a definite indicator of sewage pollution.

The sanitary survey and laboratory investigations of samples of water from suspected sources, should both be undertaken in all instances, and reliance placed on the result of the combined investigation. Many samples of water taken at different times and from

various points, may be necessary. It is likely that ice only under very unusual circumstances, ever conveys typhoid. While freezing may only kill 50 per cent of typhoid bacilli, after four weeks of storage there are as few bacteria in ice, as if it had been filtered through sand (Park). Typhoid bacilli do not multiply in ice, or in water, and in the latter they die in seven days, or less, as a rule. They disappear most rapidly from badly polluted water at higher temperatures. They probably live longest in cold water, in the winter. According to Whipple there is "no authentic case on record where a large typhoid fever epidemic has been caused by infected ice." Freezing and storage for four months renders ice relatively safe, and probably absolutely so, within six months. There is no observable increase in the prevalence of typhoid fever in the City of New York, in the spring, when ice is taken from the Hudson River and used, and the source of this ice is moderately infected, according to Park. A most interesting and important point in reference to these water-borne epidemics of typhoid is that they are almost invariably preceded by many cases of diarrhea among those using the polluted water. This is what is known as "premonitory diarrhea." There are always many cases of diarrhea in any community using sewage polluted water for drinking purposes, and these are greatly increased prior to, and during, a water-borne epidemic.

The second important mode by which epidemics of typhoid are spread is through the use of milk infected with germs of the disease. This may happen when a carrier is employed on a farm where milk is produced, or in a dairy supplying milk to people in a given community. Such milk-borne epidemics are as a rule very serious, and frequently there is a high death rate among persons so infected. Milk is a favorable medium for the growth of typhoid bacilli, and, in consequence, enormous numbers of the germs may be ingested by those using the contaminated milk, and very serious massive infection is the result. *Milk-borne epidemics have the following constant characteristics:*

1. The cases of the disease resulting from the use of infected milk nearly all occur on one milk route, and among consumers of milk from the one source.

2. Many of the cases have a short incubation period.

3. A large proportion of the cases occur among women and children.

4. More than one case is apt to occur in a given family at the same time.

5. There is no characteristic incidence.

6. The cases are more likely to occur in families who are consumers of large quantities of milk.

7. The outbreaks are especially likely to occur in communities where pasteurization of milk offered for sale is not required, or where there is no public health supervision of the milk, or milk products, offered for sale.

8. As in water-borne epidemics the onset of the epidemic is usually sudden. Sometimes cream, butter, buttermilk, ice cream or fresh cheese may be the source, not milk.

9. A thorough epidemiological investigation, including sanitary surveys of dairies (and laboratory examination of excreta of employees, from whom a history of a previous attack of typhoid fever or some gastrointestinal condition has been obtained), very often reveals the fact that the milk has been contaminated by a healthy carrier, who has been permitted to handle milk, while excreting typhoid germs, and because of uncleanly personal habits has conveyed the germs to the milk.

In the same way other foods offered for sale, may be contaminated by carriers. Or foods cooked or served in restaurants, etc., may occasionally be so contaminated. It occasionally happens that shellfish such as oysters, clams, etc., may be the source of outbreaks of typhoid, if they are obtained from waters grossly polluted with sewage. Then, occasionally raw fruits or vegetables may be handled by carriers, and unless they are carefully washed before being used as food, may be the source of infection.

The extent of an outbreak of typhoid fever, of course, depends upon the number of susceptible persons who have ingested typhoid germs in the water, milk or other food. In the past, especially in camps, etc., where proper disposal of excreta was not undertaken, serious outbreaks of typhoid have been due to contamination of food by flies, having access to human excreta containing typhoid bacilli. Such *fly-borne epidemics* are now quite uncommon and can only occur in unsanitary communities where urine, and feces, are not properly disposed of and where no water carriage system of sewage disposal exists and where there are no sanitary privies. Such epidemics occur during the height of the fly season, the late summer

and early fall, the flies acting as mechanical vectors (insect carriers) of the germs. Camps, summer resorts, and unorganized communities, unless properly supervised by competent public health authorities, will likely suffer from such outbreaks of typhoid.

Carrier Outbreaks of Typhoid

In addition to being the source from which arise isolated or sporadic cases of the disease, carriers may give rise to small scale epidemics of typhoid fever. These epidemics have the following characteristics:

1. There are relatively few cases and they occur at quite widely separated intervals of time.
2. Such outbreaks are especially likely to develop in institutions, camps, on shipboard, or in any place where a number of people are exposed to infection by food, prepared or served, and at the same time contaminated by a typhoid carrier. Occasionally a carrier whose occupation is that of a cook may give rise, by infecting food, to one or even a series of limited outbreaks of the disease in private families. An example of such is the cook known as "Typhoid Mary," in the City of New York who in a period of five years gave rise to several limited outbreaks in families by whom she was employed. In all, 26 cases were traced to this one source of infection.
3. Carrier typhoid has no characteristic seasonal incidence.

The relative importance of carriers as sources of infection can only be determined when an effort is made in every single case of typhoid fever to ascertain the source from which the patient was infected. It is well known that persons may act as carriers for very many years. There are on record a number of instances of persons acting as such for more than forty years.

Prevention and Control

Of the utmost importance in the control of typhoid is early recognition of cases of the disease. In this connection the value of blood cultures as an aid in diagnosis, early in the course of an attack of the disease, should be remembered. Too often when the clinical symptoms are not such as to lead the physician to diagnose typhoid, he may come to depend upon the result of a typhoid agglutination

test, the so-called Widal reaction. Now a positive blood culture will be obtained much earlier than will a positive agglutination reaction. Only 20 per cent of patients will give such a reaction during the first week of the disease, whereas 90 per cent will give a positive blood culture. During the second week 60 per cent will yield a positive Widal, 80 per cent in the third week, and 90 per cent in the fourth week, and a still higher percentage will yield positive results if repeated agglutination tests are made. In a great many communities public health diagnostic laboratories, state or private, are prepared to undertake blood culture examinations as well as Widal tests. This is a great advantage in assisting the physician to arrive at a correct diagnosis early in the disease, in order that suitable measures for the control of infection may be instituted.

Reference has already been made to the very dramatic reduction in typhoid mortality and morbidity during the past decade or two. This, in the majority of instances, has been the result of the installation of water purification plants, and of sewage disposal works, for the control of water-borne typhoid. Supervision and oversight of dairies and public eating places is also a duty of the health department through its division of food control. Laboratory examinations of milk samples, etc., supplemented by veterinary inspection of farms, dairies, and the correlation of these two efforts are the other links in the chain. This effort has, in many municipalities, resulted in clean water, pure milk and satisfactory public eating places being made available for everyone. The desirability of undertaking such activities is obvious.

.The control of typhoid fever, therefore, presents two aspects. The first and most essential step (already taken by nearly all enlightened communities) consists in providing adequate and safe systems of water purification and sewage disposal. The engineering phases of this are outlined in a later section. Not only provision for the erection, but funds for the proper operation of such plants, are necessary.

The influence upon typhoid death rates of installations for water purification and sewage disposal, is shown in Table XL taken from the 1918 Report of the Provincial Board of Health of Ontario. When and where laboratory (bacteriological) control of the efficiency of filtration plants was introduced, especially satisfactory results were usually obtained.

TABLE XL

DEATH RATE PER 100,000 OF POPULATION FROM TYPHOID FEVER—ONTARIO CITIES

CITY	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908	REMARKS
Belleville	0	26	81	* 63	17	18	37	19	50	40	71	
Chatham	183	21	46	8	16	58	44	30	39	68	49	Filters and Chlorination
Fort William	0	0	9	22	21	30	33	35	83	106	111	
Galt	0	0	25	0	17	27	19	31	42	11	43	Springs
Guelph	6	6	0	12	12	6	6	13	27	69	21	
Hamilton	5	4	4	6	7	14	8	24	15	16	19	Ok. Lake Ontario
Kitchener	10	5	0	5	11	6	19	7	43	15	15	Springs
Kingston	22	9	5	28	43	25	32	26	78	31	31	
London	2	5	2	0	9	3	10	17	4	6	12	Springs
Niagara Falls	8	8	27	9	34	85	44	90	60	26	84	
Ottawa	6	5	18	24	17	19	108	101	28	24	31	
Peterborough	8	0	14	14	25	10	10	17	29	6	18	
Port Arthur	0	20	21	5	50	146	163	121	178	164	138	
Sarnia	41	62	60	34	26	45	139	148	101	82	110	
St. Catharines	10	6	22	0	6	27	22	71	24	24	0	
St. Thomas	35	31	29	29	0	50	19	19	20	34	49	Filters
Sault Ste. Marie	26	46	31	24	84	127	85	280	154	90	68	
Stratford	0	0	12	17	6	6	20	13	34	34	14	Wells
Toronto	3	4	7	2	9	13	14	24	46	25	21	
Welland	68	172			82	128	39	58	85	0	0	Chlorination badly supervised
Windsor	18	38	29	35	27	10	38	34	49	56	63	
Woodstock	10	10	28	10	0	10	30	42	21	21	32	Springs
Cities Ontario	9.6	7.5	12.1	9.43	12.4	17.3	27.7	35.8	51.5	34.3	37.8	
Towns Ontario	17.2	31.4	52.2	38.0	47.4	46.0	47.0	62.3	56.4	67.7	107.1	
Rural counties	5.09	6.58	8.1	9.45	10.	13.3	10.9	16.1	22.0	25.1	20.5	
Ontario Prov.	7.52	8.4	12.05	10.7	13.5	16.7	18.7	25.3	31.5	29.9	29.7	
United States	†	13.4	13.3	12.4	15.4	17.9	16.5	21.0	23.5	21.1	24.3	
Quebec Prov.		29.15	24.2	21.4	19.9	19.0	24.3	....	....	....	....	

*Heavy line indicates year in which bacteriologic control took effect.
†Returns not available.

The cities of Windsor, Sarnia and Kingston, all obtain water from polluted sources, and the irregular results shown in the table are accounted for, in part, by unsatisfactory methods in the operation of filters, which have since been corrected; and in part by the fact that typhoid, other than that due to the use of infected water, was not controlled.

Next in importance to control of water-borne typhoid is the regulation and supervision of milk offered for sale. A by-law governing all conditions which may affect the milk supply is a necessity in every municipality. An ordinance providing for licensing, inspection and regulation of all restaurants, hotels, lunch counters and public eating places is also a necessity. No one who is a carrier of germs of any communicable disease should be permitted to find employment in a dairy, or any place where food is offered for sale. The most satisfactory procedure in any municipality is to require that all milk offered for sale shall be pasteurized. The danger of milk-borne epidemics is thus reduced to a minimum, and entirely eliminated if rigid requirements regulating the sale of certified milk are insisted upon. It is true, of course, that there is always a possibility, where certified milk is offered for sale, that infection may occur, and this should not be overlooked. Such a contingency does not arise where pasteurized milk only, is offered for sale in a community.

Assuming, then, that the physician is in practice where adequate provision has been made for those fundamental community requirements, pure water and clean milk, and that a case of typhoid cannot arise from such sources, what is the origin of a case of the disease which comes under his care? The history may reveal the fact that the patient was in some distant place ten to fourteen days before the onset of his illness, or was traveling, and in consequence infection took place outside his own place of residence. This is very frequently found to be true especially in those communities where residual typhoid only is found.

The fact that the incubation period of the disease is usually ten to fourteen days (although it may be shorter, especially in milk-borne typhoid) makes it possible for the physician to glean considerable information as to the possible source of infection of his patient. This knowledge he should obtain in every instance. In dealing with the individual case of typhoid, it is necessary to at once report the case to the local public health authority. Compulsory

notification of typhoid fever is practically everywhere required. If the patient is to be treated at home he should at once be isolated, preferably in a room which is properly screened and thoroughly fly-proof. Instructions should be given at the first visit in regard to concurrent disinfection, proper methods for the disposal of excreta, etc. The patient should have his own utensils, dishes, clinical thermometer, etc., and these should not be removed from the sick-room until after the patient has left the room. Unused food should be burned. Feces and urine should be disinfected before being disposed of. To destroy typhoid bacilli in urine, 2 parts of 1-40 carbolic acid solution, or 1-1,000 bichloride of mercury should be mixed with the urine, and contact for 1 hour, at least, in the case of bichloride solution, allowed. Carbolic acid solution requires longer, about 12 hours to destroy the bacilli. For feces, 3 per cent bleaching powder, (fresh hypochlorite of lime,) solution, or, either of the above germicidal agents may be used. A mixture of 3 parts of lime solution or 2 parts of carbolic to 1 part of excreta to be acted upon should be prepared, and thorough mixture and contact for at least one hour for the lime solution, and twelve hours for the carbolic acid solution, allowed. No other measure in individual cases of typhoid is of greater importance than proper disposition of excreta. No matter whether a water carriage system of sewage disposal is available or not these measures should always be carried out. Furthermore they should be continued until the patient is no longer excreting typhoid bacilli. Bed pans, etc., should always contain disinfectant solution. All personal and bed linen soiled by the patient should be boiled for ten minutes at least. Quarantine of contacts of cases of typhoid fever is not usually required, and as a general rule the premises are not placarded. The success attained in any community in its efforts to completely control typhoid fever depends very largely upon hearty cooperation of the practicing physician in reporting his case early, and upon the vigor displayed by the local health department in tracing sources of infection of all cases reported to the department. The inherent difficulties at present in the further control of the disease are these:

A proportion of convalescents, (perhaps 1 per cent) are likely to become healthy carriers and remain so for years, and thus their constant and continued supervision is administratively impossible. Without the cooperation of these persons they are a menace in any

community in which they reside, unless they are thoroughly cleanly in their personal habits, and refrain from engaging in any occupation in which they will have to prepare, handle or serve food, including milk. These healthy carriers may move about from place to place, and no state or provincial health department, much less any local department, can keep in touch with them, if they are unwilling to be supervised. Of course, it is obvious that they cannot be detained by compulsion for any lengthy period of time; then, too, such carriers may only excrete the germs intermittently. This, of course, is a crowning difficulty.

However, with greatly improved habits of personal hygiene and the betterment of living conditions, there is no reason to assume that those who harbor typhoid bacilli, and at times excrete them in the feces or urine, will not be anxious to aid in preventing their transfer to others. Physicians by educational effort should strive to inculcate in all their typhoid patients this point of view.

Fortunately there is one other potent weapon for the control of typhoid fever. That is specific prevention through the use of antityphoid vaccine. This method of inoculation or vaccination results in the vaccinated becoming actively immunized against the disease. The protection so conferred may last for months or years, and in some, for life. The majority of people will be immunized for about 1 year if given two or three doses of antityphoid vaccine. Though Pfeiffer, and Kolle, and Wright introduced the method of typhoid inoculation about 1894, its ultimate triumph and vindication came with the Great War. It is most valuable and particularly applicable for those who are intensively exposed to infection, especially those in hospitals and other institutions, where cases of the disease are treated. It is also valuable for persons travelling in communities where general antityphoid measures are not enforced, and where the disease is usually very prevalent. It is under all circumstances a most important auxiliary measure. Perhaps its chief field of usefulness is among the armed forces of the country, the personnel of the army, navy, etc.

Adami in a very interesting review of the results obtained by the use of antityphoid and triple (typhoid combined with paratyphoid, a and b) vaccine, among members of the Canadian Expeditionary Force, presented the following data. In the South African War,

which lasted for 2 years and 7 months, there were 548,237 men engaged. Among these there were 59,864 cases of enteric (typhoid and paratyphoid). This was an admission ratio of 122.9 per 1,000. Among these cases there were 8,248 deaths, a ratio of 18.6 per 1,000. More men died in this war from typhoid than were killed in action, or died of wounds. During the Great War in a period of four years and one month the strength of the Canadian Expeditionary Force during the time, and the number of cases of typhoid were as follows:

1914	30,000	men	9	cases	of	typhoid	0	deaths
1915	85,000	"	136	"	"	"	5	"
1916	180,000	"	163	"	"	"	3	"
1917	250,000	"	77	"	"	"	2	"
1918	275,000	"	36	"	"	"	4	"

Totals ....420,000 Men
421 Cases of typhoid
14 Deaths

Admission ratio 1.00
Death ratio 0.003

Owing to the fact that typhoid vaccine, only, was used at first, a certain number of cases of paratyphoid fever developed. Later a triple vaccine made up of a mixed emulsion of B. typhosus and B. paratyphosus a, and B. paratyphosus b was used. Before this was done there were 259 cases of paratyphoid a, with 7 deaths; and 91 cases of paratyphoid b, with no deaths.

Equally satisfactory results were obtained in the British Expeditionary Force and the American Expeditionary Force, among troops properly immunized. Russell, in an article dealing with the results obtained in the A. E. F., gave an interesting comparison (Table XLI) of typhoid mortality in the Great War, the American Civil War, and the Spanish American War.

TABLE XLI

RELATION OF MORTALITY IN THE WORLD WAR TO THAT OF PREVIOUS WARS

	Number of Deaths that Occurred in Present War, Sept. 1st, 1917-May 2nd, 1919: Average Strength Approximately 2,121,396	Number of Deaths that would have occurred if the Civil War Death Rate had obtained	Number of Deaths that would have occurred if the Spanish-American War Death Rate had obtained
Typhoid Fever	213	51,133	68,164

The method of preparation, administration, etc., of typhoid and paratyphoid vaccine is as follows:

The vaccine consists of a suspension of dead typhoid and paratyphoid (alpha and beta) bacilli, experience having shown that a mixed vaccine of this nature will give adequate protection against both infections. The vaccine is prepared in one strength only. Each cubic centimeter contains 1,000 million dead microbes, B. typhosus, and 750 million each paratyphoid A and B.

Inoculation and Dosage

Two inoculations are given at intervals of eight to ten days. For adults the first dose is ½ c.c. (7 or 8 minims), and the second dose 1 c.c. (16 minims).

Instructions for Making Inoculation

The most suitable place to make the injection is into the subcutaneous tissue immediately below the collar bone. The injection must not be made deeply into the muscles. The area should first be thoroughly cleansed with soap and water, and then some antiseptic applied. Tr. iodine diluted ½ with alcohol is very suitable for this purpose. When many individuals are to be immunized at one time, half a dozen needles of 23 gauge and 2 of 18 gauge will suffice. The rubber on the cap should be painted with tincture iodine and the 18 gauge needles plunged through the cap. To the one the syringe is attached for filling, the other allows air to enter in order to obviate negative pressure. The chest is bared and a small area just under the collar bone is painted with tincture of iodine, and, using a small sterile needle, the inoculation is made under the skin. Always use a separate sterile needle for each person and always shake the bottle well before using. The technic must be strictly followed.

Clinical Symptoms Resulting from Inoculations

Local Reaction.—In all cases a certain amount of redness occurs at the site of injection. This is quite transient, passing away within from 24 to 48 hours.

General Reaction.—This consists of malaise, slight rise of temperature, and is usually quite transient.

Those inoculated should be advised to rest for 24 hours after the inoculation. This will prevent severe reaction.

The vaccine should be kept in a cool place.

Vaccine should not be used after the date stamped on the bottom of the label.

Other measures for the control of typhoid fever should include:

Determined efforts to prevent fly-breeding by any and all means.

Methods for the sanitary disposal of feces and urine, in unorganized communities, camps, etc., by providing proper privies, latrines, etc., should be required. Bacteriological examination of the feces and urine of typhoid convalescents and contacts, should be made, and carriers should be definitely instructed how to absolutely avoid being a menace to others in the community.

PARATYPHOID FEVER

Paratyphoid fever is a disease which clinically is very often so similar to typhoid fever that differentiation is only possible by means of a bacteriological examination of the blood and the excreta of persons ill with the disease.

Incidence

Paratyphoid fever is found in all parts of the world. It is not one of the important causes of death even in those communities where it is fairly prevalent. Because of the fact that in very many cases typhoid and paratyphoid are not differentiated by laboratory methods, the actual prevalence of the disease is not known. The disease is endemic and is very frequently found in those communities where typhoid also is endemic. Rosenau found that in Washington, D. C., 1 per cent of cases reported as typhoid were really paratyphoid. The disease is only occasionally epidemic and then only on a limited scale. The disease is more prevalent in India and certain other tropical countries than elsewhere. It was found both in Gallipoli and in France among British troops in 1915, and a few cases were observed among men who had not served in the Mediterranean Expeditionary Force, but occupied billets with those who had. The number of cases of paratyphoid in the Canadian Expeditionary Force was 350 compared with 421 cases of typhoid. This proportion

is to be accounted for by the fact that protection against typhoid by vaccination long preceded that against paratyphoid.

Etiology

Paratyphoid fever may be caused by B. paratyphosus, alpha, or B. paratyphosus, beta (Schotmüller). These two species of microorganisms can be differentiated from B. typhosus, and from one another, by means of certain biochemical reactions (fermentation of carbohydrates), and by means of specific agglutination tests. Each forms its own specific agglutinins, and this permits of recognition by serological methods.

Modes of Transmission

Man, as in the case of typhoid fever, is the sole reservoir of infection in this disease. The germs enter the body, as they do in typhoid fever, in water or food which has been contaminated with excreta eliminating them. The germs are present in the blood early in the disease, and are later found in the feces and bile, and much less commonly in the urine. Paratyphoid is more frequently transmitted by infected food (especially milk) than by water. The germ does not multiply in water but will do so in milk, and in other foods. In certain countries in Europe, meat such as sausage, etc., has often been the medium for the transfer of the germs of this disease. Frequently, paratyphoid has a slightly briefer incubation period than typhoid. It is also a less fatal disease, having a mortality of about 3.5 per cent, against 9 per cent for typhoid. One attack of the disease probably establishes a more permanent immunity than does an attack of typhoid.

Carriers are very important in the transmission of paratyphoid. Some cases of so-called food poisoning may really be paratyphoid, and outbreaks of cases of a vague condition of gastroenteritis may mean that a carrier, employed in the capacity of a cook, or waiter, is responsible for the condition.

Prevention and Control

Cases of the disease should be reported at once to the local board of health, and the patient if treated at home, must be isolated. Cases of paratyphoid and typhoid can also under many circum-

stances, be much more satisfactorily treated in hospital than at home.

All other measures indicated for the control of typhoid should also be employed in the prevention of paratyphoid, including specific vaccination.

DYSENTERY

Under this designation are included two clinical conditions. Bacillary dysentery, an acute communicable disease of microbic origin, and amebic dysentery, a chronic disease due to a protozoan parasite.

Incidence

The acute disease, bacillary dysentery, occurs in all parts of the world. It is especially prevalent in semitropical communities where unsanitary conditions exist, and in camps, or isolated communities where water-carriage systems of sewerage, or sanitary privies do not exist. As a cause of death this type of dysentery is not nearly so significant as are diarrhea and enteritis in children under two years of age. Fatal cases of bacillary dysentery are probably included in the deaths registered as due to diarrhea and enteritis, and are described as "infectious diarrhea." Outbreaks of dysentery are occasionally observed in institutions, on shipboard, etc. These epidemics are usually quite limited. The disease frequently prevails in endemic form. Since definite recognition is only possible by careful bacteriological and serological investigation, many cases go unrecognized, and the majority of the cases of the disease definitely established, are those treated in hospitals where such investigations are undertaken as a matter of routine.

The disease is more prevalent in the summer months than at other times. The largest number of cases occur in July, August and September. According to Shiga, young men of the age of 20 to 30 especially suffer from dysentery; perhaps because there is greater exposure among this age group.

Etiology

Bacillary dysentery may be due to B. dysenteriae, Shiga, (1898) or B. dysenteriae, Flexner (1900), or to some other strain of

dysentery organism closely akin to the latter. The dysentery bacilli described by Shiga are unable to ferment the carbohydrate mannite. This distinguishes them from all other strains, or closely related species. They also give rise to specific agglutinins, so they may also be differentiated from the others by means of the agglutination reaction. B. dysenteriae, Flexner, and all others such as the "Hiss—Y," Strong, Park and other strains, all ferment mannite, and usually receive the generic of "mannite fermenters," while Shiga bacillus is a nonfermenter of mannite.

Modes of Transmission

The disease is peculiar to man. The species of bacteria which cause the disease are found in the intestinal tract of persons suffering from the disease, and of healthy carriers. The condition has a very short incubation period, usually only two or three days. It is rarely as long as eight days. In the typical case of the disease watery stools containing mucus, often blood stained, are passed by the patient very early in the disease. These flecks of mucus and blood contain enormous numbers of bacilli, and unless the stools containing them are disinfected, or properly disposed of, the germs may be conveyed to others. Dysentery bacilli are excreted only in the feces, not in the urine. The germs are both in endemic and epidemic outbreaks of the disease, probably conveyed to food either by (a) the hands of patients or carriers, or by (b) flies which have access to excreta containing the germs. Water-borne epidemics of the disease have occurred in Japan, and in certain of the Islands of the West Indies. Generally speaking, however, dysentery is more commonly the result of the ingestion of food (including milk) contaminated with the germs of the disease. Infection is transferred directly or indirectly, as indicated above. The disease may be communicated to others by a careless patient, convalescent or healthy carrier, still excreting dysentery bacilli. This, of course, is also true of typhoid and paratyphoid fever. Personal or bed linen, or other articles soiled with bowel discharges of patients or carriers may, of course, be the source from which the germs are carried either to food or water.

Prevention and Control

An outbreak of acute enteritis, especially among young adults (in communities or places where there is inadequate control of public water supplies, where no sewage disposal system exists, no sanitary privies and numerous flies) may be an epidemic of bacillary dysentery. If large numbers of persons are passing stools containing blood or mucus, or both, bacteriological and serological examinations should be made, to ascertain whether dysentery bacilli are present. Early recognition of the disease is very important, and pending the bacteriological confirmation, persons who are passing such stools should be isolated, and the stools carefully disinfected with some germicidal agent as recommended in typhoid fever, or the germs destroyed by steam sterilization. The patients should be isolated until dysentery bacilli are no longer being passed and until all symptoms of the disease have subsided. Carriers should be sought for, during any outbreak in a camp, or institution, especially if sanitary conditions are unsatisfactory and flies are not prevalent. If found, such carriers should not be permitted to prepare, or serve food of any sort, and should be instructed regarding precautions to be taken to avoid infecting others. The death rate from this disease may be quite high. Among troops in Gallipoli, during 1915, it is said to have caused a mortality of 6 to 30 per cent.

In places where general sanitary conditions are bad these should be corrected. If the epidemic occurs during the fly season, every precaution must be taken by screening, etc., to protect all food supplies from flies. Kitchens and dining-rooms should be enclosed, and their surroundings such that the fly menace will be reduced to a minimum. Provision for the proper disposal of human excreta should also be made. Specific prevention of bacillary dysentery is possible through the use of a dysentery vaccine. A considerable measure of success has attended the use of a polyvalent antidysenteric serum in the treatment of the disease. To be effective, treatment should be instituted early, carried on vigorously, and the serum administered intravenously if necessary. Much care should be exercised in isolated communities, or in institutions, to prevent infection of attendants, etc. These may either develop the disease or become healthy carriers, unless they exercise due caution in washing the hands frequently, and by wearing a gown, when in con-

tact with the patient, or anything he may have soiled. In typhoid, paratyphoid and dysentery as in all other communicable diseases, separate clinical thermometers, etc., should be provided for each patient. Other general measures for the control of this disease are the same as in typhoid fever.

AMEBIC DYSENTERY

Amebic dysentery is a chronic infection in which relapses occur, and characterized by symptoms of enteritis and sequelae such as liver abscess, etc. It is especially prevalent in the tropical communities.

Incidence

The disease occurs in sporadic and endemic form, and is very seldom seen outside the tropics. It does not occur in epidemic form. Very many cases of amebic dysentery have been observed in Egypt, India, the Philippines and in certain parts of Europe. It has been observed only on rare occasions, in the Northern United States and Canada. It does occur in the Southern United States, Mexico, in Central and South America. In tropical communities where it is endemic, it is said to be most prevalent during the summer months. The largest number of cases are seen in young adults, especially males. In many tropical countries amebic dysentery is an important cause of death.

Etiology

Lösch in 1875 established the fact that this type of dysentery is caused by a protozoan parasite, an ameba. There was, for a considerable period of time, doubt as to which species of ameba was responsible for the production of the disease. It is now, however, recognized that the specific causative agent is Endameba histolytica.

Mode of Transmission

The disease has a long chronic course and is characterized by relapses. The sources of infection are those persons who are giving off in the feces, amebae, usually in the form of cysts. The parasite is not excreted in the urine. Walker and Sellards found in human volunteers, artificially infected, that the incubation period of the

disease ranged from 20 to 94 days, but, on an average, was about two months: As in bacilliary dysentery, the cases, in the acute stage of the disease, may pass stools containing blood and mucus, and in these are many amebae. After passing through a stage of acute diarrhea, the infected persons may have an intermission which lasts for several months, then another attack of diarrhea may supervene. This often continues for years.

The excreta of patients unless disinfected or otherwise suitably dealt with, is the source of infection. The amebae find their way into water or food, and this is especially true in the tropics where water may be scarce, and where pollution of the soil with human excreta is very common. Water from surface wells, etc., is frequently contaminated and conveys infection, or vegetables washed with such water may be the source. Occasionally vegetables, or fruit, eaten in the raw state may have been contaminated with soil containing amebae, and infection is thus acquired. As a result of the persistence of the parasite in the body for considerable periods of time, liver abscesses frequently occur. Unsanitary conditions and lack of proper provision of pure water, and the absence of sanitary privies favor the occurrence of the disease. Persons are able to transmit infection as long as they continue to excrete amebae in the stools.

Prevention and Control

The diagnosis of the disease may be confirmed by the discovery in the stools of the amebae. They are often found in the encysted state. Therefore, a search should always be made for cysts, as well as for amebae in the free state, in the stools of those suspected of harboring the parasite. The isolation of those found to be suffering from amebic dysentery until they are cured; the use of food that has been thoroughly cooked; and of water that is known to be pure, are essentials in the control of the disease. Very many healthy carriers exist in certain communities and they render the problem of complete control a difficult one. Prevention of soil pollution is of great importance, and this presupposes a desire on the part of those living in such communities to improve sanitary conditions generally.

Fortunately for the treatment of the individual case, emetin, an alkaloid of ipecac, has a specific effect on the amebae, absolutely destroying them when they are in the vegetable, or free state. It

is powerless to destroy encysted amebae, but under long continued emetin treatment the cysts gradually disappear if in combination with such treatment, active purgation is produced. The same general prophylactic measures are indicated in amebic dysentery as have been outlined in the discussion of other intestinal infections.

INFANTILE DIARRHEA: DIARRHEA AND ENTERITIS IN INFANTS

Infantile diarrhea is, in many respects, the most serious public health problem among the diseases which are characterized by symptoms of gastroenteritis or enteritis. In the main, these deaths are due to improper feeding or to infection.

Incidence

In the registration area of the United States in 1919, there were 37,635 deaths in children under two years, due to diarrhea and enteritis. These conditions were tenth on the list of the causes of death. The death rate per 100,000 of population was 44.2, and 3 per cent of all deaths registered were due to those causes.

Table XLII from the Report of the Registrar-General of Ontario illustrates, for the past ten years, the extent of mortality from this cause.

TABLE XLII

DEATHS FROM INFANTILE DIARRHEA—PROVINCE OF ONTARIO
1910 - 1919

The number of deaths reported from diarrhea and enteritis, amongst children under two years of age. The number was lowest in 1917, when 663 were reported. An increase was reported in 1918 and a further increase in 1919.

	TOTAL DEATHS UNDER 2 YEARS FROM D. & E.	DEATHS UNDER 1 YEAR	DEATHS 1 YEAR AND UNDER 2 YEARS
1910	1,374	1,239	135
1911	1,367	1,188	179
1912	1,146	979	167
1913	1,993	1,751	242
1914	1,215	1,075	140
1915	1,189	999	190
1916	1,218	1,026	192
1917	663	556	107
1918	845	719	126
1919	967	848	119

Fig. 31, showing in the upper curve, the infant mortality rate for the last forty years in Ontario, and in the lower curve, the death rate of children under one year who died from these causes, indicates the great significance of diarrhea and enteritis as a cause of infant mortality.

INFANT MORTALITY—ONTARIO
RATIO OF DEATHS UNDER ONE YEAR, PER THOUSAND LIVE BIRTHS

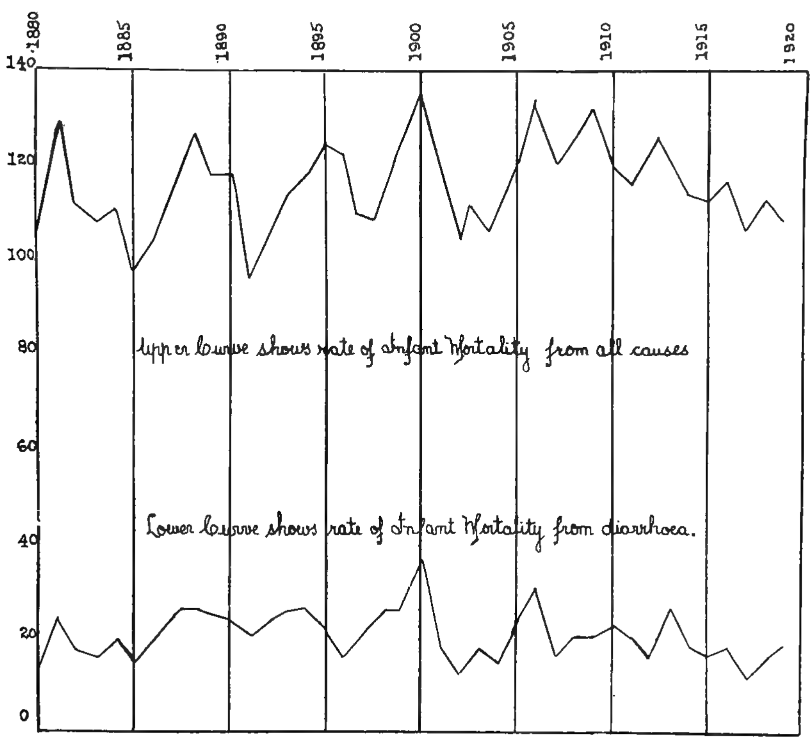


Fig. 31.

The largest number of these deaths are recorded during the summer months. They thus have a very definite seasonal incidence.

Etiology

Occasionally these cases of diarrhea and enteritis in young children are due to infection. In a small percentage of cases B. dysen-

teriae is the etiological agent. Perhaps more frequently streptococci or B. coli is responsible. In the large majority of cases improper feeding perhaps combined with infection is probably the cause. Park writes as follows, in regard to these cases: "They should be made reportable and treated as infectious diseases so as not to transmit slightly pathogenic streptococci or colon bacilli." Rosenau regards bacillary dysentery as a common disease, and in connection with these cases of infantile diarrhea states "it would be a wise precaution to consider all cases of infantile diarrhea as infectious, and to take precautions accordingly."

Mode of Transmission

Cases of diarrhea and enteritis in infants and young children when caused by pathogenic germs arise as a result of the ingestion of such in milk and water. Milk containing great numbers of bacteria, and water which may be polluted with intestinal bacteria, undoubtedly are frequently responsible for the causation of many of these cases. In unsanitary communities and places, especially in the summer months, flies may convey harmful germs to milk or other foods to which they have access.

Prevention and Control

The reduction in morbidity from diarrhea and enteritis and the control of deaths from these causes emphasizes the necessity for carrying on a vigorous well-baby and child hygiene campaign, in every community.

Strict supervision of food and water to guard against contamination, is a first requisite, and instruction of mothers in regard to proper methods of infant feeding, is also of the utmost importance. This, of course, is a part of the work done in every well-baby clinic or center, and physicians in private practice should be equally zealous in their efforts to diminish the number of these preventable deaths.

ASIATIC CHOLERA

Asiatic cholera is an acute communicable disease which has at many times in the past been widely epidemic in nearly all parts of

the world. Formerly it was much more widespread than it is at present.

Incidence

According to Dunbar, asiatic cholera "occurs in the form of epidemics which, following the paths of human traffic, spread quickly over wide areas, and carry off 50 to 55 per cent of those affected." Hirsch distinguishes four pandemics up to the year 1875. The first lasted from 1817 to 1823 and prevailed only in Asia and Africa. The second lasted from 1826 to 1837, and the third from 1846 to 1862, and the fourth from 1864 to 1875. The last three affected Asia, Africa, Europe and America. The fifth pandemic began in 1883 and lasted until 1896. The sixth, in 1902-1904, invaded Egypt, Persia, Russia and Turkey. The disease has many times encircled the earth, following the lines of travel or trade-routes. India, and chiefly Southern Bengal, including Calcutta (the Delta of the Ganges) has always been the starting point of epidemics, and is the present home of the disease.

During recent years the disease has appeared outside India in epidemic form, in 1912 in Italy, in Galicia, and in other countries in Europe. It does not occur now in countries where an effective maritime quarantine service is maintained, and where, in the past, efforts were made to completely control the disease. It is confined at present to tropical and semitropical countries where a completely satisfactory sanitary administration is not yet established.

Etiology

The disease is caused by the vibrio of asiatic cholera, sometimes called the spirillum of cholera. The germ was first isolated in 1883 by Koch. The present completely effective control of the disease in all those countries now happily free from cholera epidemics, is the result of this discovery, and of subsequent work of the same bacteriologist.

Mode of Transmission

It required the great epidemic in Hamburg in 1892, to prove conclusively that cholera is the result simply of microbic invasion alone, and not a matter of the invasion of the germ plus suitable environmental conditions, and other favorable factors in the body of the human

host. It has been proved experimentally, though as the result of an accident, that cholera vibrios when swallowed by a human being produce the disease, and that no other factors enter into the question. Oergel, an assistant in the Hamburg Hygienic Institute, accidentally infected himself by drawing into his mouth, through a capillary tube, some fluid rich in vibrios, and died of cholera.

The incubation period of this disease is one to five days and usually one to two. As has been suggested it may be endemic and epidemic. When epidemic it may be conveyed through the use of water polluted with human excreta containing the vibrios. These germs, unlike typhoid bacilli, not only live for weeks or months in water, but they even multiply in it. The great epidemic in Hamburg in 1892 was water-borne. Indeed all great epidemics of the disease have been water-borne.

When the disease is endemic, however, infection may be conveyed by other means than through the use of polluted water. In epidemic or residual cholera, however, water-borne infection may be of minor importance, in comparison with carriers of the disease. Large numbers of those who have had cholera, continue to excrete the germs of the disease for a time. These are convalescent carriers. But even more important in the transmission of the disease are the healthy carriers. That is, in places where the disease is epidemic, between 5 and 10 per cent of those exposed to infection may ingest the vibrios, yet show no symptoms of the disease, but are found to be excreting the germs and are thus a great menace to others.

Cholera vibrios are excreted in the feces and in the vomitus, but they are not given off in the urine. Carriers excrete them in the feces only. Since the vibrios may live for a considerable time in water, they may very readily be ingested, if such polluted water is used for drinking purposes. Milk contaminated by a cholera carrier may be the mode of conveyance of infection, as may also fruit and vegetables washed in contaminated water or handled by a carrier. Flies may carry the organisms from excreta to food. Finally, soiled linen, etc., unless carefully handled, may be the means of conveying infection to persons who are careless in their personal habits. Carriers are not only responsible for the spread of endemic cholera but they are also responsible for its persistence in those countries where it is still found. Cholera vibrios have been found to persist in the stools of convalescents for periods ranging from 10 to 69 days.

Diagnosis

The recognition of the disease at the earliest possible moment is of the utmost importance. Diagnosis is finally verified in those presenting clinical symptoms of the disease, by the isolation of the vibrio, and establishing its identity. The characteristic rice-water stools swarm with these organisms, and they can be readily isolated by cultures made in Dunham's peptone water solution. A fleck of mucus placed in a tube of this medium gives rise to a luxuriant growth of vibrios, swimming on the surface of the culture fluid, in from eight to twelve hours. They are tested for morphology, motility, staining reaction, etc., and then a specific agglutination test is made. They are easily agglutinated with even highly diluted anticholera serum, and if necessary Pfeiffer's phenomenon can be demonstrated. That is, a small quantity of emulsion of the living vibrios is introduced into the peritoneal cavity of a guinea pig, in which is also placed a small quantity of anticholera serum. The microorganisms undergo bacteriolysis, and smears made from the peritoneal fluid, after a short time show the disintegration of the cell bodies of the germs.

Prevention and Control

In all countries where the disease does not exist at present, maritime quarantine is the chief barrier against the introduction of cholera. Ships arriving at ports in the United States and Canada (and the same is true in Great Britain and elsewhere), from seaports in countries where cholera is known to be present, are held at quarantine until it is established that there are no cases of the disease on board. In addition, persons who have come from districts where the disease is known to exist are detained in a special hospital at the quarantine station, and careful bacteriologic examination of their stools is made. Those found to be harboring vibrios are detained until they cease to do so. A very careful scrutiny of passengers is made to discover any mild or even ambulatory cases which may be among those endeavoring to land. At Ellis Island, New York, in 1912, 34,000 bacteriological examinations of stools were made of persons arriving there from places where cholera was rampant at that time; as a result 28 cases of the disease were discovered and 27 healthy carriers, also. The great value of mari-

time quarantine was demonstrated at that time. Thousands of immigrants were coming into the country, many of them contacts of persons who had cholera in the communities from whence they came, but the disease gained no foothold whatever in the United States or Canada. A bacteriological examination carried out in a laboratory of the quarantine station is requisite in many cases, in addition to the medical inspection and detention for five days.

Where a case of the disease occurs, immediate notification of the fact to the medical officer of health is required. Premises where cases of the disease are treated, are placarded unless the case is sent to hospital, and a quarantine of contacts is at once established. The patient is isolated, and every precaution taken to prevent the further spread of the disease. Stools, vomitus, bed and personal linen must all be disinfected by chemicals, or by steam sterilization, or boiling. Attendants and nurses must exercise special care to avoid infection, by washing their hands every time they handle anything which may have been contaminated by the patient. Flies must be rigidly excluded from the sickroom. Only carefully disinfected or boiled water, and carefully cooked food prepared and served by persons of cleanly habits and known not to be cholera carriers, should be used. Wearing special clothing when in contact with patients will also safeguard the personnel which is necessary for the care of cholera patients. Where the disease has gained a foothold, special hospitals are usually established. Attached to the hospital should be a bacteriological laboratory where the examination of stools of convalescent patients, or carriers, may be undertaken in order that such may not be permitted to leave hospital until at least 2 successive negative stools, at a 5 day interval, have been obtained.

In addition to the above measures it is possible to employ a cholera vaccine, first recommended by Haffkine, to aid in the control of the disease. The vaccine is simply an emulsion of killed cholera vibrios, and very considerable success has attended its use. The mortality among vaccinated groups has been reduced from about 75 per cent to 42 per cent and the liability to contract the disease is about twice as great among the uninoculated as it is among the inoculated. The immunity conferred by this vaccine lasts, as a rule, for about one year.

HOOKWORM DISEASE: (ANCHYLOSTOMIASIS)

Hookworm disease is a chronic, communicable disease, due to the invasion of a small worm, most frequently through the skin, but occasionally by ingestion.

Incidence

The prevalence of hookworm disease is more largely confined to tropical and semitropical countries than elsewhere. In this regard it is comparable to many protozoan diseases. There it prevails in endemic form. It does not manifest itself in epidemic outbreaks. In countries in the temperate zone, it is found among mine workers in parts of Wales, and in Northern Europe, in the workers in the mines, in Belgium, France, Holland, Germany and Spain. It is most prevalent in Egypt and other parts of Africa, in South America, in China, India, Ceylon, Australia, the West Indies, Cuba, Porto Rico, and in the following American States: North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana and Texas. According to Chandler it is estimated that 500,000,000 people throughout the world have hookworm infection. In the United States, Stiles has estimated that about 2,000,000 people harbor hookworms.

Etiology

The parasites responsible for this disease are nematodes, roundworms, and either one of two species of worm may be responsible for infection. The first is Anchylostoma duodenale, the European species of hookworm; the other is Necator americanus, the American species. The latter is the smaller of the two. The male worms of the American species are about $\frac{1}{3}$ of an inch long, while the males of the other species are about $\frac{2}{5}$ of an inch long. The females vary from $\frac{2}{5}$ to $\frac{3}{5}$ of an inch in length.

Mode of Transmission

It is necessary to know the details of the life history of the hookworm in order to understand how infection is spread. The adult worm is found in the intestinal tract of man. The female worms produce great numbers of eggs which are poured into the intestinal tract of the infected person. These somewhat developed eggs are

passed out in the feces, more or less continuously. The eggs have a thin shell and are very small, about $\frac{1}{400}$ by $\frac{1}{700}$ of an inch in size. Before leaving the intestine they undergo the first stages of development, and are segmented into from 2 to 8 cells. The segmented eggs are clear and unstained when passed out. If the eggs are deposited in a suitable warm moist soil and are exposed to the air, development continues, and embryos are hatched in from twenty-four to forty-eight hours. The temperature of the soil must not be below 65° F. or above 85° F. if further development is to progress most satisfactorily. The young larvae hatched from the eggs are likely to die unless suitable food (decaying organic matter) and sufficient moisture is available. The newly hatched worm is $\frac{1}{100}$ of an inch in length. Under favorable conditions the larva grows rapidly for four or five days and after that time sheds its skin. At the end of five days the skin again becomes loose but is not shed. The parasite has grown and measures about $\frac{1}{50}$ of an inch in length. It is now in an infective state and is ready to enter a human host and take up its parasitic existence. These young worms migrate in the soil and enter water, or remain just below the surface of moist soil or mud. They may remain in the soil for months in this stage.

Occasionally it is believed that these immature worms may be swallowed in polluted water and find their way to the intestinal tract. But Loos has shown that in 90 per cent of cases, the young worms enter the body through the skin. In tropical and semitropical communities, where the disease is most prevalent, many persons go about with bare feet and the parasite enters a hair follicle, pierces the skin and finds its way into a lymphatic vessel. It is then carried to the nearest lymph gland, from whence it is conveyed to the thoracic duct, and then to the vena cava. It is next carried to the heart and passes from the right ventricle to the lungs. It is now caught in a fine capillary in the lung and pierces the wall of an alveolus. It next progresses up the respiratory tree and is finally coughed up through the trachea and larynx, and is swallowed. Finding its way through the esophagus and stomach it ends its journey in the small intestine, to the wall of which it becomes attached. The larvae shed their skins twice more after entering the human body, and they also grow to adult size. The incubation period is from seven to ten weeks. As long as the worms, or eggs, are found in the feces, an individual may transmit infection to others.

Diagnosis

The symptoms of the disease may be both local and general. The site of entrance of the parasite, in the skin, may become ulcerated and give rise to the condition known as "ground itch." Secondary infection with bacteria may also take place in this situation, and cause an aggravation of the local sore. The general symptoms are due to the loss of blood and consist of a profound anemia, weakness, listlessness and often marked apathy, lowering of resistance to other diseases such as tuberculosis. It is an important cause of death in various parts of the world. In Porto Rico it is said that 30 per cent of all deaths are due to hookworm disease.

Prevention and Control

The first step in the control of the disease is the demonstration of the presence of the parasite, or its eggs, in the stools of suspected cases, by means of a laboratory examination. In countries where this condition is prevalent, hookworm surveys are undertaken as a preliminary, to ascertain the extent of infection. Very often this survey is extended, and a demonstration in control immediately follows the initial survey.

Persons found to be infected are treated with thymol, or betanaphthol, and at the same time educational work is carried on among the inhabitants of the community, to explain the nature of the disease and to outline measures which should be taken to avoid infection. The greatest difficulty encountered is the widespread and intensive pollution of the soil with human excreta where the disease exists. This is due to the lack of sanitary privies, especially in rural districts. Soil pollution is the most important factor in the continued enormous incidence of hookworm disease. Its ultimate control depends, therefore, upon the prevention of soil pollution by the installation of sanitary privies, and the adoption of measures which will make it impossible for the parasite to enter the skin. Provision must also be made for adequate supplies of pure water. Great economic losses may be avoided by the adoption of such methods. The International Board of Health of the Rockefeller Foundation has carried on very extensive hookworm demonstrations for a number of years past, and the results of these efforts have recently been summarized by Howard.

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CHAPTER VIII

INSECT-BORNE DISEASES

The third great division of the communicable diseases includes those the etiological agents of which are conveyed by various species of insects.

Many of the diseases are due to protozoa, and among them are the most significant of all the causes of death and disability. In contemplating the various problems of preventive medicine, the fact is sometimes not sufficiently emphasized that an insect-borne disease, malaria, is the first on the list of causes of death, if the total mortality throughout the entire world, in any year, is considered. Furthermore, if to this is added hookworm disease, due also to an animal parasite, it will be realized that these are the cause of more sickness, a greater number of deaths, and an infinitely greater economic loss to mankind than are any other two diseases. Cancer, tuberculosis and pneumonia are powerful enemies of mankind, but actually, the Captains of the Men of Death are Malaria and Hookworm. Public health is becoming more and more a matter of international concern, that is, the health and well-being of the inhabitants of any community are of significance to those living in all other countries. While it is true that nature has kindly placed some barriers in the path of certain transmissible diseases which impede their pandemic spread throughout the world, there are many others which if permitted to go unchecked in one country become a menace to all others. Sir Ronald Ross has put forward many arguments to prove that the downfall of Greece was due to the invasion of malaria and not to the military prowess of her enemies.

Tremendous advances have been made in the last four decades, in the knowledge of these devastating diseases. Many of the most fascinating chapters in the history of medical science filled with deeds of real heroism are to be found in the field of parasitology; that branch of biology which deals with the morphology, life-history, methods of transmission, etc., of those minute foes of man which

belong to the animal kingdom. The most important protozoa, pathogenic for man are:

(1) Spirochetes,

(2) Hemoflagellates and allied forms including (Trypanosomes, Leishmania, etc.),

(3) Amebae,

(4) Hemosporidia,

(5) Flagellates,

(6) Rickettsia.

And, in addition, certain of the Nematodes or round-worms are also of importance in this connection.

Most of these animal parasites are harmful in a variety of ways. They may excrete toxic substances which act deleteriously on the host, or they may cause injury mechanically, or, finally, they may rob the host of food and thus exert a pernicious influence. Of course, there are many animal parasites of man which lead a harmless existence in the body. These are the so-called commensals.

The harmful animal parasites gain access to the human body by different paths. The most important, perhaps, is by direct contact, as in the case of the spirochetes of syphilis and yaws, and in hookworm infection, when the parasite pierces the skin. Or it may be ingested, as in the case of amebic dysentery and a certain percentage of cases of hookworm infection. The next, and perhaps most important of all methods, by which protozoan diseases of man are conveyed is by biting insects. These are the insect-borne diseases. It is with this group that the present chapter deals most extensively. Not all of the protozoan diseases will be considered, only those which from the standpoint of public health are most significant.

Medical entomology had its birth in 1879 when Sir Patrick Manson made the significant discovery that a species of filarial worm found in a certain tropical disease of man, could only undergo complete development in the body of another host, namely, the mosquito. Manson found that the circulating blood of patients with this disease contained enormous numbers of what appeared to be young forms of a certain kind of worm. He knew that these worms were not given off in the excreta and he undertook to explain how they were conveyed from man to man. He conceived the idea that a night-flying biting insect might be responsible

and he advocated this view. Later on Manson and others, were able to confirm this and laid the foundation of knowledge of the *biological* transmission of disease by insects. By this is meant, the capacity of certain insects to act as intermediate hosts for various species of parasites. The insect bites an infected human being, and withdraws some blood containing certain parasites. The insect then harbors these parasites for a time, and in its body the parasite goes through a definite cycle of development. Furthermore, in the case of certain insect-borne diseases, unless, and until, the parasite goes through this stage of development, the insect is powerless to transmit them to other human beings that it may bite.

In the body of man then, the parasite undergoes one stage of development, in the body of the insect, another. If the insect bites the infected human being when the parasite is in an appropriate stage in its development, the insect becomes infected. Subsequently after the parasite has undergone a further stage in its life cycle it is again in a stage in which, if it is conveyed by the insect to man, it may produce in the latter, the symptoms of the disease which it causes. The species of insects which convey the causative agents of disease are known as vectors. Human beings capable of conveying and transmitting to others disease-producing germs are, as we have seen, known as carriers.

Next to Manson's great discovery, that residence in insect hosts is necessary for the complete development of certain parasites was the observation of Smith and Kilbourne, in 1893, that a certain animal disease, Texas fever, was conveyed only by the transmission of infection through the agency of a biting insect. It was established by these pioneer investigators that this cattle disease was due to an intracorpuscular blood parasite (Babesia bovis) and that it was conveyed only by a tick (Boophilus annulatus).

Now, in addition to the biological transmission of certain diseases by insect vectors, there are other diseases in which the causative agent undergoes no development in the body of the insect, and is simply conveyed by it to a human being. Many of these diseases are caused by bacteria, which have a very simple life history and multiply by simple fission. The transfer of the germs of cholera, or typhoid, from human excreta to food, or directly to man are examples of the mechanical transmission of infection by insects, as is

also the conveyance of plague bacilli from rats to man by fleas. On the other hand, the transfer of the parasite of malaria by mosquitoes is an example of biological transmission of a parasite, by an insect vector.

Some of the more important of the insect-borne diseases are given in the following table. In each instance, where the cause of the disease is known definitely it is given; also the name of the insect vector. To this is added the name of the persons credited with the discovery, and the date of the same.

TABLE XLIII

SOME OF THE MORE IMPORTANT INSECT-BORNE DISEASES

DISEASE	CAUSE	INSECT VECTOR
(1) Malaria	Plasmodia (Laveran 1880)	Mosquito (Anophelines) (Ross 1898)
(2) Yellow Fever	Leptospira icteroides, (Noguchi—1919)	Mosquito (~~Stegomyia~~ calopus) American Yellow Fever Commission (Reed, Carroll, Lazear and Agramonte, 1900)
(3) Plague	B. pestis, (Yersin and Kitasato, 1894)	Flea, any one of several species (rat, cat, dog, human, etc.) (Liston—1905.) Indian Plague Commission—1906.
(4) Filariasis	Filaria bancrofti (Bancroft—1876)	Mosquito (Culex fatigans and other species) (Manson—1879)
(5) Trypanosomiasis	Trypanosoma gambiense (Forde and Dutton—1901)	Tsetse-fly (Glossina palpalis) (Bruce.)
(6) Typhus Fever		Body-louse (Pediculus vestimenti) (Nicolle—1909)
(7) Dengue Fever		Mosquito (various species of culex and anophelines) (Graham—1902)
(8) Rocky Mountain Spotted Fever	Rickettsia	Tick (Dermacentor venustus) (Ricketts—1906)
(9) Relapsing Fever	Spirochaete (any one of several varieties) (Obermeier—1873)	Tick and Louse (Nicolle—1915)
(10) Trench Fever	Rickettsia	Louse (Allied Trench Fever Commission—1918)

MALARIA

The most widespread disease in the world today, malaria, is caused by a protozoan parasite.

Incidence

Estimates of the enormous prevalence of malaria are available, and they are sufficient to indicate how widespread it is and the great mortality for which it is responsible. Von Ezdorf of the United States Public Health Service, as a result of data obtained from morbidity reports, estimated that 4 per cent of the population of eight southeastern states, that is about 1,000,000 people, annually suffered from malaria (Chandler). L. O. Howard has estimated that 3,000,000 cases of malaria occur annually in the United States. And, of course, malaria is much less widespread in the United States than it is in various other parts of the world. In Italy, and elsewhere in Southern Europe, in different countries in Central and South America, in Asia, and Africa, it is exceedingly prevalent. In some tropical countries 1 person in every 3 is said to have malaria.

Etiology

The cause of malaria is any one of several species of protozoan parasites of which there are many belonging to the genus, plasmodium, and the class Hemosporidia (sporozoa). They are so called because they reproduce by splitting up into small divisions or spores. They are nonmotile and live in, or on, red blood cells. There are three important and distinct species of plasmodia any one of which can give rise to malaria under appropriate conditions. These may be shown as follows:

Sub Kingdom ....Protozoa
Class ....Sporozoa
Sub-class: ....Telosporida
Order: ....Hemosporidia
Genus ....Plasmodium
Species: (a) Plasmodium vivax—cause of "benign tertian" malaria.
(b) Plasmodium falciparum—cause of "malignant tertian" malaria (aestivo-autumnal)
(c) Plasmodium malariae—cause of "quartan" malaria.

The malarial parasite was discovered by Laveran in 1880. Various stages in the development of these parasites in the blood of human beings, was described by Golgi in 1885, in the case of the parasite of quartan fever. This was the first proof that there were a number of phases, or steps, in the growth and multiplication of

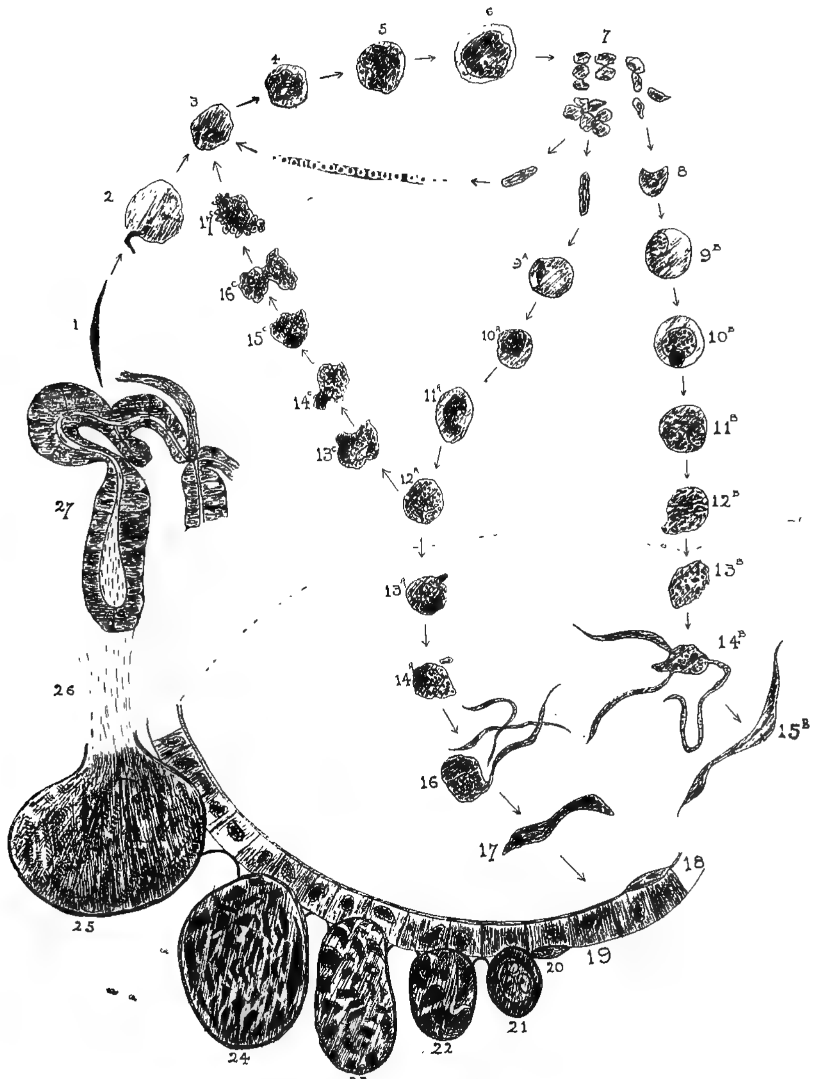

Fig. 32.—Life-cycle of the tertian parasite (Plasmodium vivax). After Lühe, based on figures by Schaudinn and Grassi. *1*, sporozoite; *2*, entrance of the sporozoite into the red corpuscle; *3, 4*, growth of the parasite, now sometimes called a torphozoite; *5* and *6*, nuclear division in schizont; *7*, free merozoites; *8*, the merozoites which have developed making their way into the blood corpuscles. (arrow pointing to the left) and increase by schizogony (*3-7*); after some duration of disease the sexual individuals appear; *9A-12A*, macrogametocytes; *9B-12B*, microgametocytes, both still in the blood-vessels of man. If macrogametocytes (*12A*) do not get into the intestine of Anopheles they may perhaps increase parthenogenetically according to Schaudinn (*12A; 13C-17C*). The merozoites which have arisen (*17C*) become schizonts *3-7*. The phases shown underneath the dotted line (*13-17*) proceed in the stomach of Anopheles. *13B* and *14B*, formation of microgametes; *13A* and *14A* maturation of the macrogametes; *15B* microgamete; *16*, fertilization; *17*, oökinete; *18*, oökinete in the walls of the stomach; *19*, penetration of the epithelium of the stomach; *20-25*, stages of sporogomy on the outer surface of the intestinal wall; *26*, migration of the sporozoites of the salivary gland; *27*, salivary gland with sporozoites. (From "Animal Parasites of Man" by Fantham, Stephens and Theobald.)

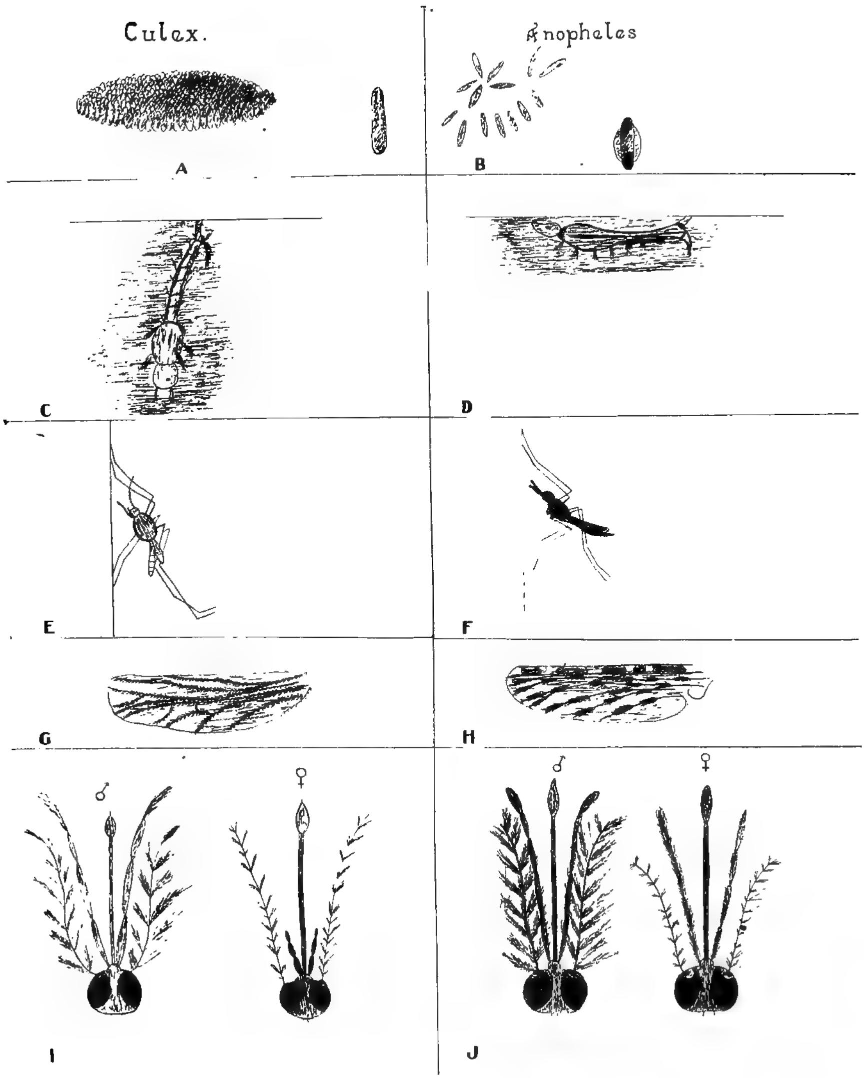

Fig. 33.—Chief comparative characteristics of Culex and Anopheles. Egg of Culex, *A*, laid together in "small boat"; those of Anopheles, *B*, separated and rounded. Larvae of Culex, *C*, hangs nearly at right angles to water surface, those of anopheles, *D*, are parallel to surface. Body of Culex, *E* when resting is held parallel to wall in a curved position, that of Anopheles, *F*, stands at an angle of about 45° and is straight. Wings of Culex, *G*, are generally not spotted, those of Anopheles, *H*, are spotted. In Culex, the palpae, I, of the female are very short, of the male longer than the proboscis; in Anopheles, *J*, the proboscis of both sexes are about of equal length. (From Kolle and Hetsch.)

the parasite in or on the red blood cells. This is now called the *asexual cycle* of development. The benign and malignant tertian parasites go through all stages of development in the human host, in about forty-eight hours. The quartan parasite requires seventy-two hours to complete development. In these periods the parasite enlarges, and then sporulates, that is, divides into a great number of immature parasites. They may enter other red blood cells, or a certain number of them may grow and become differentiated sexual forms (male, microgametocytes; female, macrogametocytes). It is only when these immature sexual forms find their way into the stomach of the mosquito that they become mature, and fertilization takes place. This happens when an infected human being is bitten by a mosquito of an Anopheles species, when the blood in the peripheral circulation of the infected person contains parasites.

The developmental stages during which the male and female cells (microgametocytes and macrogametocytes) become microgametes and macrogametes, respectively, and then unite, occur in the stomach of the mosquito. This development is known as the sexual cycle. This sexual cycle requires from ten to twelve days. The *asexual* cycle, then, takes place in man, the human host; and the *sexual* cycle in the insect host, the mosquito. The life cycle of the tertian parasite (Plasmodium vivax) is shown in Fig. 32.

Ross in 1897 and 1898 discovered that the transfer of parasites in a disease of birds, similar to malaria, in man, was brought about through the agency of mosquitoes. He advanced the view that this was the mode of transfer of malarial parasites from one person to another. Bignami, Bastianelli and Grassi, three Italian investigators, established the facts that Ross' hypothesis was sound and that malaria was transmitted in this way. Experimental confirmation was also furnished by Low and Sambon and P. T. Manson in 1900. The latter was infected with malaria by mosquitoes, sent from Italy, that had fed on patients having the disease.

Mode of Transmission

The incubation period of the disease is ten to fourteen days, occasionally, however, it may be as brief as five or six days. As has been indicated above, malaria can be transmitted only by the mosquito. Furthermore, only mosquitoes of some Anopheles species

are able to convey infection. Culex, the ordinary day-flying mosquitoes can ingest human malarial parasites, but these do not develop in this species. According to Fantham, Stephens and Theobald, "transmission of the blood of patients to healthy people produces a malarial affection, which corresponds in character to the fever of the patient from whom the inoculation was made." The Anopheles are night-flying mosquitoes though they may occasionally bite in the day time. Only the female Anopheles can transmit infection. There are several of these species, the females of which are capable of transmitting the malarial parasite. The commonest of these are—in Europe, Anopheles maculipennis; in North America, Anopheles quadrimaculatus. The important characteristics of the Culex and Anopheles mosquitoes are shown in Fig. 33.

Carriers play a very important part in maintaining the present incidence of malaria. Ross has shown that there must be a certain number of infected human beings and sufficient numbers of the intermediate insect hosts (mosquitoes) before the disease will become prevalent in any community. Human beings, in malaria, as in many other diseases, serve as reservoirs of infection. An individual may harbor malarial parasites for years and only occasionally have attacks of the disease. Malaria is indigenous chiefly in tropical and semitropical countries.

Diagnosis

After a healthy person has been bitten by a mosquito and has received the parasites of malaria, these begin to develop, and usually after ten to fourteen days, occasionally after five or six, they have multiplied to such an extent that enormous numbers are found in the blood. The patient now begins to show the characteristic symptoms, a shivering chill, headache, lassitude, then pronounced rise in temperature, often vomiting, etc., and this is followed by a period of profuse sweating. After a time this subsides, the temperature drops, and the patient becomes again fairly comfortable. These periods last from six to ten hours in benign infections, and for about twenty hours in malignant. The attacks are repeated every forty-eight hours in tertian malaria and every seventy-two hours in quartan. These attacks are synchronous with the sporula-

tion of the malarial parasites and their liberation into the circulation.

The attacks for the first fortnight in benign malaria are fairly severe, but then may subside and under treatment, cease. In malignant malaria, however, death occurs early in the attack in quite a large percentage of cases. Either type of case may become chronic and persist for years. According to Chandler about ¾ of the life cycle of these parasites is passed in the plugged capillaries, and in only one-fourth can they readily be found in the circulating blood. One attack of the disease does not confer immunity.

Persons who have had malaria a long time before may for a considerable period appear to be free from infection, then as a result of something producing a considerable reaction, as, for example, the injection of some foreign protein, they may again manifest symptoms of the disease. This is sometimes called "latent" malaria.

Prevention and Control

The prevention of malaria is an economic as well as a public health problem. It may be considered under the heads of mosquito control, specific prevention and treatment by the use of quinine, and the combination of these in administrative measures necessary for control or elimination. These are, of course, interrelated, and it is impossible simply by an attack on malaria-conveying mosquitoes, or by efforts directed against persons harboring parasites alone, to obtain the desired end.

The specific control of malaria even in part, is made possible owing to the fact that quinine has the power to kill the malarial parasites. However, some of these parasites occasionally become resistant and they are then not destroyed by quinine. Fortunately, however, cases of malaria that begin treatment early and in whom such treatment is carried on vigorously, only occasionally present this difficulty. Many different methods of disinfecting patients who are harboring the organisms of malaria have been suggested. The National Malaria Commission in the United States recently appointed a subcommittee to consider the question and make a concrete recommendation. This they have done, and their suggestions were published in the Public Health Reports of the United States Public Health Service on December 26, 1919, and

are as follows: "For the purpose of curing the patient of his infection and in the majority of cases * * * prevent relapses and also prevent transmission of infection to others it is recommended that in the acute attack 10 grains of quinine sulphate be given by mouth three times a day for three or four days followed by 10 grains each night before retiring, for a period of eight weeks. For infected persons not presenting acute symptoms at the time, only the eight weeks' treatment is required. The proportionate doses recommended for children are:

Under 1 year	½ grain
1 "	1 "
2 years	2 grains
3 to 4 "	3 "
5, 6, and 7 "	4 "
8, 9, and 10 "	6 "
11, 12, 13, and 14 "	8 "
15 years and over	10 "

"It is not claimed that this is a perfect, or even the best treatment in all cases, but it is a good and satisfactory method for practical use to prevent relapses and transmission of the disease to other people."

The control and extermination of the mosquitoes involves the application of many methods. For personal protection Howard recommends, as a repellant a mixture of oil of citronella 2 parts, spirits of camphor 2 parts (equal parts by weight) and 1 part of oil of cedar poured on a towel hung at the head of the bed, and rubbed on the hands and face at night.

The elimination and exclusion of mosquitoes from buildings is much more important than the first measure. Fumigation with sulphur may be used to eliminate the mosquitoes, or cresyl, 75 grains to 35 cubic feet may be employed or their exclusion accomplished by the use of screens or mosquito net. Such net or screen should not be less than 18 meshes to the inch. Cloth is said to be more effective than wire. Mosquitoes finding their way through crevices, etc., should be killed with a fly swatter.

The destruction of the mosquito larvae by oiling the surface of ponds, etc., (their breeding places) is accomplished by pouring a light fuel oil on such surfaces—an ounce of petroleum to 15 square feet of water surface. A film is thus produced which will last ten days.

The film prevents the larvae from obtaining air. In the tropics because of rapid evaporation, torrential rains, etc., other methods are necessary. According to Chandler at Ancon, Canal Zone, a combination emulsion and larvacide is used. It consists of 150 gallons of crude carbolic acid heated to 150° C., 150 to 200 lbs. of powdered resin stirred in, 30 lbs. of caustic soda added and the mixture stirred and kept hot until black liquid soap is formed. This forms a milky emulsion with water and kills larvae and also forms a film on the surface of the water. The destruction of the breeding places of mosquitoes by drainage, etc., is the third valuable mode of attack; and finally fish which are the natural enemies of mosquito larvae may be introduced into ponds, pools, etc., which for any reason cannot be drained, and this obviates the necessity of repeatedly oiling the surface of the water in the breeding places.

It has often been demonstrated in recent years that any community can by the adoption of adequate administrative measures

TABLE XLIV

	CROSSETT	HAMBURG	LAKE VILLAGE	DERMOTT	MONTI-CELLO	BAUXITE
Population	2,029	1,285	975	2,760	3,023	2,500
Physicians' Calls for Malaria*						
1915	2,500	....	....	....	....	....
1916	741	2,312	1,817	1,399	1,413	862
1917	200	259	1,388	1,248	1,274	729
1918	73	59	83	162	137	172
1919	77	33	96	84	81	47
Percentage of reduction for Entire Period of Work	96.9	98.6	94.0	93.6	94.0	94.1
Per Capita Cost**						
1916	$1.24	....	....	....	....	....
1917	.63	$1.45	....	....	....	....
1918	.53	.44	$1.25	$0.54	$0.46	$1.11
1919	.62	.78	1.08	.65	.44	1.14

PHYSICIANS' CALLS FOR MALARIA, AND THE PER CAPITA COSTS, FOR SIX TOWNS IN ARKANSAS

The International Health Board of the Rockefeller Foundation, co-operating with the local health organizations of these towns, undertook experiments that developed into convincing demonstrations that it is feasible and economically practicable to control malaria. The problem is one of preventing the breeding of the Anopheles mosquito. These figures show the rapid decrease in the number of physicians' calls for malaria following the beginning of control measures, and demonstrate that the cost is within the means of the average community.

*Heavy line indicates beginning of control operations.
**First year's per capita cost omits overhead. Figures for later years are for total costs.

and the expenditure of sufficient money control malaria. Therefore, united community effort rather than haphazard attempts are essential if any place is to rid itself of malaria. Furthermore it has been shown that such efforts cost much less than does medical

THE RESULTS OF MALARIA CONTROL MEASURES

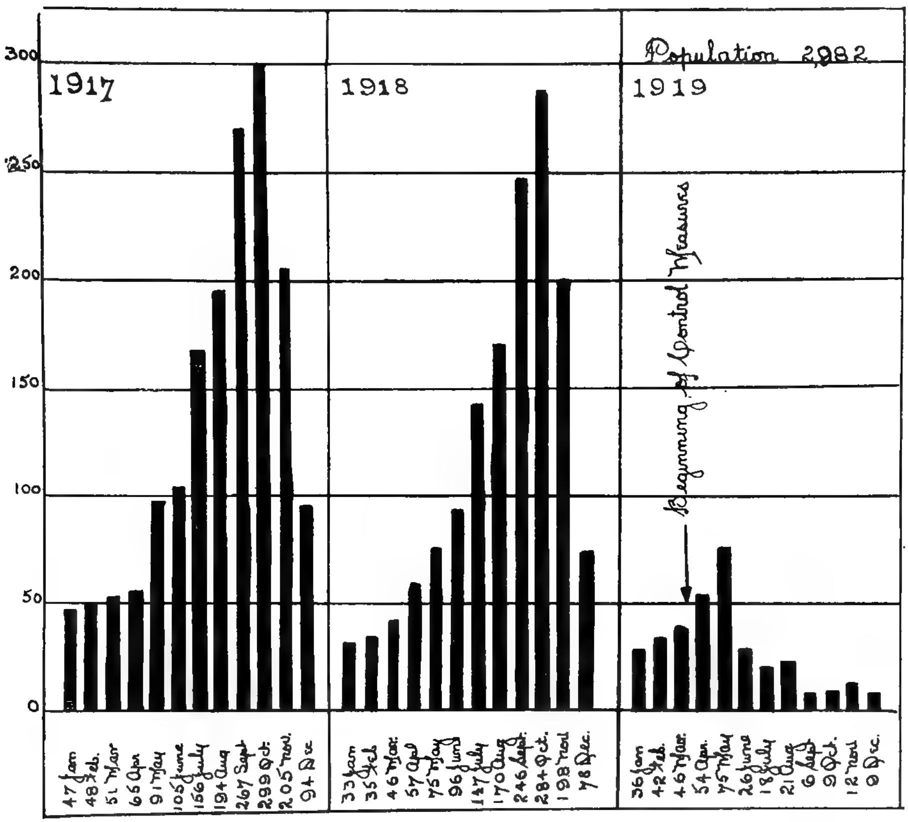

Fig. 34.—In the town of McGehee, Arkansas, the number of physicians' calls for malaria was greatly reduced following the introduction of control measures in 1919. Before these measures were introduced, October showed the highest number of physicians' calls for malaria—299 in 1917 and 284 in 1918—but the figures dropped to 9 in 1917, seven months after the beginning of antimosquito measures. Plans are perfected for similar demonstrations in 1920 in 10 Southern States through the co-operation of the International Health Board, the State Board of Health, and the U. S. Public Health Service.

and nursing service for those suffering from malaria, to say nothing of the prevention of the economic loss inevitable through absence from work on account of illness.

Ross in many tropical parts of Great Britain's Colonial possessions and Gorgas at Havana, and on the Isthmus of Panama have shown that malaria can be completely controlled by the adoption of appropriate measures as indicated above.

YELLOW FEVER

An insect-borne disease seen chiefly in tropical communities formerly appearing in epidemic outbreaks, yellow fever is now present in endemic form only.

Incidence

Until quite recently yellow fever was one of the great scourges of the tropics and especially of tropical seaports. It was carried from tropical countries in the summer. Before it was known how yellow fever was conveyed and before effective quarantine was instituted, it was one of the most serious menaces to all cities which are in direct communication through the trade routes, with tropical seaports. There remain only a few places where yellow fever is now endemic, and nearly all of these are unsanitary communities. It is found on the West Coast of Africa, in Guayaquil, in Ecuador, and Bonaventura in Columbia, in Vera Cruz and several other cities in Mexico and in certain cities in the Central American Republics. New Orleans, Havana, Rio de Janeiro and other cities have succeeded in eliminating the disease and outbreaks like that of 1905 in New Orleans are unlikely to recur in the future.

Relatively very few cases now occur in these endemic foci and those that are observed are reported in the weekly summary, under the designation "prevalence of disease," foreign and insular section, of Public Health Reports issued weekly by the United States Public Health Service.

Etiology

In 1919 Noguchi described a fine microorganism akin to the spirochetes to which he has given the name Leptospira icteroides. It is closely related to the species of microorganism which is thought to be the cause of hemorrhagic jaundice, namely, the Leptospira icterohemorrhagica. It is a very small organism and readily passes through the pores of a Berkefeld filter, that is to say, it is filtrable. This parasite, Noguchi believes, is the cause of yellow fever, and

while the matter is not finally determined there is reason to hope that the question of the etiology of the disease has been settled at last.

Mode of Transmission

In 1900 in Havana the American Yellow Fever Commission consisting of Reed, Carroll, Lazear and Agramonte settled for all time the question of the mode of transfer of infection in yellow fever. They were able to prove that the disease is conveyed only by a species of mosquito, the Aëdes calopus, (Stegomyia fasciata) that only the female of this species is able to transmit the causative agent, and finally, that these mosquitoes cannot transmit it until from twelve to fourteen days after having sucked blood from a person suffering from yellow fever. The parasite evidently undergoes a cycle of development in the body of the mosquito as does the malarial parasite. This is another example of biological transmission of an insect-borne disease. The incubation period of yellow fever is from three to six days. This important contribution to scientific knowledge made by Reed, Carroll, Lazear and Agramonte was a magnificent example of self-sacrificing endeavor. Lazear died in Havana of the disease in the fall of 1900. Later Carroll died of a condition which developed as a result of his attack of yellow fever. No finer example of devotion to the highest scientific ideals and the desire to benefit mankind by the elucidation of essential facts has ever been given. Their work has made possible the absolute control of this once greatly dreaded disease.

Persons with yellow fever (and man alone is naturally susceptible to infection) are apparently in an infective condition from three to four days only, after the first onset of the symptoms. That is, mosquitoes cannot transmit the virus unless they bite yellow fever patients during the first few days of the disease.

Diagnosis

The characteristic symptoms are headache, fever, slow pulse, yellow skin, changing to coffee brown and severe vomiting, often of blood; a history of exposure to infection clinches the diagnosis. Yellow fever is a very highly fatal disease as a rule. The building of the Panama Canal by the French was made impossible because of the ravages of yellow fever and malaria. General Gorgas as chief Sanitary Officer of the Canal Zone, eliminated yellow fever

and made the construction of the Canal possible. One attack of the disease confers a permanent immunity.

Prevention and Control

Extermination of the yellow fever mosquito, Aëdes calopus, is the method by which the disease can be eliminated where it now

ONE STEP IN THE ERADICATION OF YELLOW FEVER

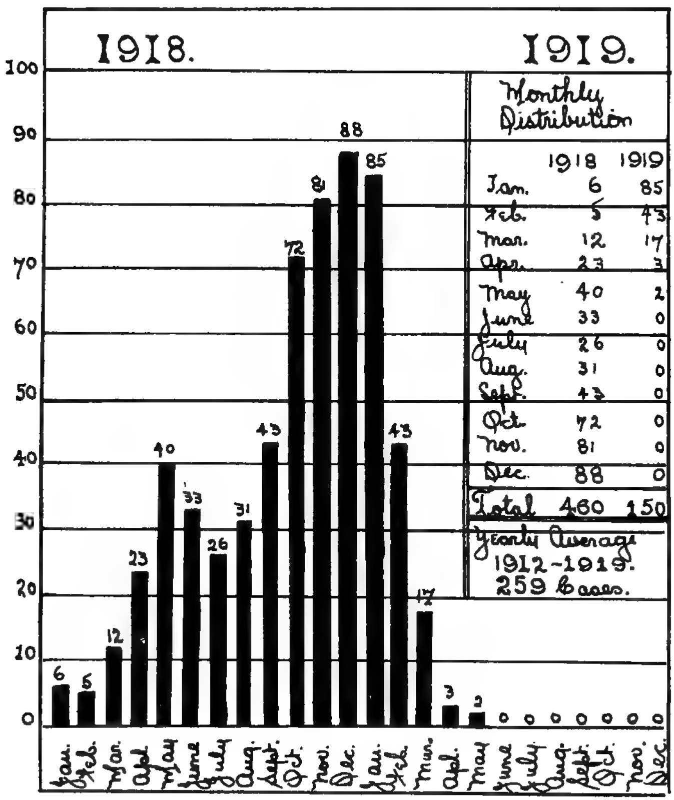

Fig. 35.—Chart showing the sharp decline in the number of yellow fever cases in Guayaquil, Ecuador, since the beginning of control measures November 25, 1918. Not a case since May, 1919, in a city where the disease had been continuously present since 1842. The figures at the top of the black columns indicate the number of cases reported during each month of the two years, 1918-1919.

It is too early to speak finally. Vigilance will be continued for at least a year. But it is believed that this city, which has so long been the most stubborn epidemic center, is at last freed from the ravages of this disease. To take the fight to the few remaining seed-beds of yellow fever is the definite program to which the Rockefeller Foundation is now committed.

exists. The Yellow Fever Commission of the Rockefeller Foundation has recently given an example of this in Guayaquil. This is shown in the following diagram from the Rockefeller Foundation Review for 1919. (Fig. 35.)

This species of mosquito is not at all difficult to exterminate because of its life habits. It is a day-flying species, is especially likely to bite in the early morning or in the afternoon. It breeds only in the vicinity of houses, in rain barrels, etc., and leaves its usual haunts, human dwelling places, only to lay its eggs. It can, as a rule, therefore, be exterminated by mosquito control measures adapted to its particular habits of life. The entrance into countries now free from infection of the disease is made impossible by adequate maritime quarantine. Vessels arriving from tropical seaports where yellow fever has been observed are detained until a clean bill of health can be given to all those on the ship.

Recently Noguchi has proposed the use of an antiyellow fever vaccine, prepared from cultures of Leptospira icteroides for the specific control of the disease and an antiserum for its treatment. The value of these remains to be ascertained.

TYPHUS FEVER

(Spotted Fever, Hospital Fever, Jail Fever, Camp Fever, Ship Fever)

An acute communicable disease, insect-borne, occurring chiefly among persons and in communities where standards of personal cleanliness are low.

Incidence

Typhus fever was clinically differentiated from typhoid fever in 1836 by W. W. Gerhard of Philadelphia. In the past very serious epidemics of the disease have occurred, especially where there was overcrowding in unsanitary quarters and where personal uncleanliness prevailed. In 1812-13 there was a great epidemic among Napoleon's troops in Russia. Another widespread epidemic appared in 1836. From 1846 to 1848 it was prevalent in the British Isles and in 1846, in Ireland, there were thousands of cases and many deaths. During that year many Irish immigrants came to North America and among them there were many cases of typhus.

Shiploads almost, of these unfortunate people died on their way across the Atlantic or on the ships held in quarantine or in special hospitals established at quarantine stations. At Grosse Ile, the Canadian Quarantine Station below Quebec several thousands of these persons died from typhus fever during 1846. Many others died in Montreal in the same year. The disease was epidemic during the Crimean War in Sebastapol, in 1854-56. In 1873 Berlin witnessed an epidemic of this disease, and in 1874-76 Prague was the center of an outbreak, as was Vienna in 1875. During the Russo-Turkish War of 1878 the troops engaged suffered from typhus. In New York in 1881-82 and again in 1892-93 the disease was widespread.

Of recent years it has been limited in its appearance to countries where community hygiene and sanitation is inadequate. In 1906 in Mexico and Cuba, in 1915 in Serbia (where 150,000 people died during that year) Poland and Galacia very widespread and highly fatal epidemics were observed. For many years a disease in Mexico known as tarbardillo has been prevalent. This is now (thanks to the work of Goldberger and Anderson and Ricketts and Wilder) known to be typhus fever. In 1910 Brill described a disease in New York which also has since been identified as typhus. This condition was sporadic and was seen in European immigrants as a rule. Typhus is now endemic in countries which for one reason or another have an inadequate public health service and where people in large numbers harbor lice. During the latter part of 1920 the disease was present in endemic form in Poland, Russia, Mexico, Chili, Egypt, Greece, Ireland, Jugo-Slavia, Turkey, Czechoslovakia, etc. The disease is more prevalent in the winter months than at other times. The more backward or unfortunate a community the more likely it is to have typhus. Human misery, poverty, want and personal uncleanliness are ever associated with the presence of this disease.

Etiology

Three views are at present held as to the cause of typhus:

(1) That it is due to a *filtrable virus;* the nature of which is unknown.

(2) That it is caused by a gram-positive anaerobic bacillus, the so-called *B. typhii exanthematicus of Plotz.*

(3) That it is probably due to a peculiar pleomorphic microorganism, named, by da Rocha Lima; *Rickettsia prowazeki* (Wolback, Todd and Palfrey).

This latter view is also supported by work of Arkwright and Bacot. The question, therefore, cannot be regarded as being definitely settled.

Mode of Transmission

As a result of the work of Nicolle in 1909 it is now known that the louse is responsible for the transmission of the cause of the disease from one person to another. Goldberger and Andreson, and Ricketts and Wilder, confirmed and extended these observations and it is generally believed that typhus is not conveyed in any other way than by the louse. Head lice and body lice may both act as vectors. Whether the parasite that causes the disease goes through a cycle of development in the louse (biological transmission) or is simply carried mechanically by the louse is a matter that is not yet settled. At least one scientific worker, Ricketts, lost his life in endeavoring to solve certain of the problems of etiology and transmission of typhus. The facts already gleaned explain why typhus occurs only in persons living in overcrowded, filthy, unhygienic surroundings.

Diagnosis

Typhus is a disease characterized by a sudden onset with a high fever, intense illness, asthenia, delirium, and other serious symptoms, a macular or papular rash like measles, and in from 20 to 50 per cent of cases in epidemics, collapse and death. Or, the fever may drop by crisis, and recovery is then rapid. Sporadic cases may be mild and the death rate quite low, 10 per cent or less. The incubation period of the disease is from five to twenty days, about twelve on an average. One attack usually confers immunity.

Prevention and Control

With a decrease in lousiness there has been a marked diminution in the incidence of typhus fever. Where the disease is prevalent the first essentials are adequate means for delousing patients, contacts and all others exposed to infection. Then steps must be taken

to keep those exposed to the disease free of head and body lice. Immediate and strict isolation of patients is necessary. Head lice may be destroyed by the use of gasoline or kerosene (equal parts of olive oil and kerosene) rubbed into the hair and this then covered with a cloth. If repeated this treatment will kill both lice and eggs. Or, the hair having been first close cropped, the head is washed with hot water and soap and 10 per cent tetrachlorethane applied in soap solution. Cleansing hot baths are, of course, necessary as a preliminary to this treatment. Those who are in attendance on cases of typhus must take very especial precautions to avoid becoming infected with these parasites, by wearing suitable garments, keeping the hair closely cropped, etc.

To destroy lice in or on clothing they may be immersed in kerosene or sterilized by steam at 70° C. for 10 minutes. This is said to destroy both lice and their eggs. Lice may be carried for long distances on clothing from infected individuals. These insects may be eliminated from rooms by sulphur dioxide fumigation. Elaborate delousing units, bath-houses, laundries, etc., may have to be established in communities where typhus is prevalent, and where an intensive antityphus campaign is to be carried on.

There also, a special typhus hospital may be desirable.

In countries where typhus does not now exist adequate quarantine is the first barrier, and fortunately in addition, in many countries the general level of personal cleanliness is so high and lousiness so uncommon except perhaps in overcrowded quarters of large cities that a second and even more effective barrier is created. Conditions are then not favorable for widespread dissemination of the disease.

Recently expeditions have been sent to where the disease is widespread to clear up doubtful points in the knowledge of the disease. Among these the Commission consisting of Strong, and his associates who worked in Serbia in 1915 and Wolbach, Todd, Palfrey and others in Poland in 1920 have made substantial contributions and the reports dealing with the results obtained should be consulted.

ROCKY MOUNTAIN SPOTTED FEVER

A highly communicable, insect-borne disease occurring in certain Northwestern States of the United States. A similar disease known

as kedani or flood fever occurs in parts of Japan, in certain of the East Indian Islands, Malay States and Sumatra (Chandler).

Incidence

Rocky mountain spotted fever is most prevalent in Montana (especially in the Bitter Root Valley) and Idaho, but is also seen in Utah, Wyoming and Nevada, and a few cases have occurred in Washington, Oregon and Northern California. The disease is limited to these communities where a wood-tick, *Dermacentor venustus,* is found. The cases are most often seen in the spring and early summer and it occurs chiefly in men between the ages of twenty and forty.

Etiology

The cause of the disease is thought by many to be a species of Rickettsia as originally suggested by Ricketts and later emphasized by Wolbach and Frick. Wolbach has transmitted the disease to monkeys and guinea pigs, and the microorganism found in these animals is identical with that found in infected ticks.

Mode of Transmission

As a result of the work of Wilson and Chowning in 1902, of King and especially of Ricketts and his associates in 1906, it has been definitely established that this disease is conveyed by a species of wood-tick, the Dermacentor venustus. The parasite which causes the disease probably undergoes a cycle of development in the body of the tick which requires several days. Both the male and the female ticks are able to transmit infection. The incubation period of the disease in man is usually from 4 to 7 days, it may occasionally be less, however.

Diagnosis

There is always a history of tick-bite a few days before, in every case of the disease. The onset is fairly sudden with chills, fever, malaise, weakness, severe headache, restlessness with a temperature of 103°-104° F. on the second day. This increases and may be highest between the fifth and seventh days, when it sometimes reaches 105°-107° F. There is a morning fall and evening rise in

the temperature. About the third day a rose-red macular rash appears on the wrists and ankles and spreads over the body. The rash disappears on pressure and then reappears. In the fatal cases the fever increases, the rash becomes confluent, the patient is profoundly prostrated and death occurs on or about the twelfth day. In the milder cases the fever subsides by lysis, the rash disappears and desquamation occurs during the third week. The mortality from the disease has been as high as 75 per cent and as low as 5 per cent. In a series of reports by Wilson and Chowning, 88 died, a mortality of 70 per cent.

Prevention and Control

The disease occurs only between March and July, the season of the year when the tick is active. It requires 2 years for the tick to mature. The insects infest rodents which are susceptible to the disease and may transmit it to ticks that are not already infected. Prevention of spotted fever, therefore, consists in destroying these ticks and also eliminating rodents on which they breed.

PLAGUE

An acute communicable disease, primarily of rodents, secondarily of man, notable in the past as one of the greatest scourges of mankind, transmitted usually by insects, but sometimes directly from one person to another.

Incidence

Plague is a disease that has been prevalent for many centuries. There have apparently been epidemic outbreaks in various parts of the world since 500 A.D. It is stated that about one-half of the people of Rome died of plague at that time. Ever since, the disease has been endemic and at times epidemic in many parts of the world. In the fourteenth century between the years 1348-1349 plague swept over Europe and it is established that about 25,000,000 people, or one-quarter of the entire population of Europe died of the disease at that time. This was the epidemic known in history as the "Black Death." This has been described by Daniel Defoe. At that time, too, great epidemics among rats were observed. It is probable that the great mortality from plague was due to the fact

that pneumonic rather than bubonic plague was rife. Western Europe has been free from plague since the middle of the 18th century, since that time the disease has been prevalent in the Orient, and chiefly in India. There was an extension of the disease in 1839 to Hong-Kong. China and Asiatic Russia have suffered much from the plague during the 19th century, and in 1900, California and the Pacific Coast States were invaded. In India the disease has been most prevalent in and about Bombay. Between the years 1896 and 1907, there were more than 5,000,000 deaths from plague in India alone.

In 1899 plague broke out in Santos, Brazil, and these were the first cases reported in the Western Hemisphere. Since that time the disease has occurred in Mexico, Central America, and as already indicated, in California (chiefly in and about San Francisco). At present Brazil, British East Africa, Ceylon, Chili, Manchuria, Hong-Kong, Ecuador, India, Mexico, etc., are endemic foci of plague. The Madras Presidency in India is now the chief source of cases. The greatest number of cases in India are reported between April and the middle of June. The disease may occur, however, in the winter or summer.

Etiology

The causative agent of plague, Bacillus pestis, was isolated by Yersin and Kitasato independently in Hong-Kong in 1894. This bacillus produces a very potent endotoxin. The germ is pathogenic for man, and in addition for many species of lower animals including rodents, such as rats, ground squirrels, tarbagan, marmots, etc. This latter fact is of much practical importance. In rodents the disease produced is often of a chronic character. The endotoxin of plague bacilli produces characteristic lesions, namely, hemorrhagic exudation and infiltration especially at the site of inoculation, also in the lymphatic glands, spleen and occasionally in other organs when a septicemia occurs.

Mode of Transmission

Liston in 1905 and the India Plague Commission (Lamb, Liston, Rowland and Petrie) appointed by the British Government the next year established the fact that bubonic plague is transmitted by the flea. B. pestis is carried from rats or other infected rodents

to man when it passes through the broken skin and sets up the disease. There is in addition to bubonic plague another clinical type of the disease, namely, pneumonic plague. In the former, lymphatic glands are chiefly involved, in the latter the lungs. Apparently plague septicemia, while it may occur, is quite uncommon. Ordinarily, cases of plague in rats first develop. Infected fleas, the most important species of which is the rat flea Xenopsylla cheopis, (Liston, 1905) then convey the disease to human beings. If the disease is endemic many cases of bubonic plague are observed but soon cases of pneumonic plague may occur and then infection may be transmitted directly in coughing, spitting, sneezing, etc., from a case of human plague to other persons. While there are two modes of transmission, sporadic cases of the disease and its endemic incidence are the result usually of transmission from infected rats or other rodents to man. In other words, it is primarily a disease of rodents and secondarily and almost by accident, an insect-borne disease of man. The species of fleas, of which there are several in addition to the rat-flea (including the human flea, Pulex irritans, etc.) which convey plague to man do so mechanically, and they probably do not infest man unless the rodents which have harbored them die. They desert dead rats or ground squirrels and transfer themselves to human beings on the death of these rodents. A period of three days usually elapses before the flea coming from a dead rat bites man. The incubation period of the disease in man is not more than five days, and on the average about three days.

Diagnosis of Plague

The disease is recognized by the characteristic symptoms of headache, fever, vomiting, swollen lymphatic glands, etc. Puncture of swollen glands should be undertaken. Smears should be made of this gland juice and the characteristic gram-negative bipolar bacilli searched for. Cultures should also be made and guinea pigs inoculated. In suspected cases of pneumonic plague the sputum must be examined as well. In many seaports where ships arrive from countries where plague is endemic, rats about the wharves may become infected by fleas which have infested rats which have plague on these ships. This not infrequently happens at the ports of London and Glasgow. Dead rats found under such circumstances must always be examined for evidence of plague. In California, the ground squirrels have

been infected by rats brought from plague infested communities, and as a result, these rodents also have to be examined to determine whether they have died of plague. The germ belongs to the hemorrhagic septicemic group of bacilli, but produces a characteristic disease picture in animals so that the identification is usually not difficult.

Prevention and Control

In countries where the disease is not now present, maritime, or other quarantine, is the effective method of preventing the disease from acquiring a foothold. A vigorous rat extermination campaign, especially in seaports and the rat-proofing of buildings about docks, etc., where ships may arrive from the Orient is necessary. Such ships may be held in quarantine until fumigated and hawsers, etc., by which the ship is tied up may be dealt with so that rats cannot get ashore. Once rodents in any community become infected with plague bacilli the utmost activity is necessary to prevent their spreading infection broadcast.

Plague is primarily a disease of rats and other rodents. Occasionally it occurs among them in epidemic form; it is then known as rat epizootic. This condition and plague are always associated in countries where the disease is now present. An increase in plague among rats almost invariably precedes a similar increase in the number of human cases. The species of rats which most often have plague are Mus decumanus and Mus rattus. The disease is spread from one country to another by infected rats of these species carried in ships. Therefore, vessels from seaports infested with plague rats require to be investigated. Plague was conveyed to Australia from India in this way. In addition to rats in India, ground squirrels in California, and other species of rodents, the tarbagan in Russia is the means of conveying plague. When the disease has been observed in rodents and because of inadequate housing arrangements such infected rodents transmit the disease through the flea, to man, about 12 days elapse between the time when infected rats are found in a house and when a case of plague is reported. In India this often means a fatal case, because mild cases may not be notified.

The control or complete elimination of the disease is very difficult in a community where it has become established among rodents. Immediate isolation and notification of cases is required and vigor-

ous measures should be undertaken to lessen the number of rodents (rats or ground squirrels). A plague laboratory and special hospital are usually requisite.

Specific vaccination by means of an antiplague vaccine has been recommended and utilized by Haffkine and others with a very considerable measure of success. The incidence of the disease and the death rate is materially lower among vaccinated than unvaccinated persons. The immunity conferred by the vaccine is not permanent. A serum for the specific treatment of plague has also been prepared and used with a certain degree of success.

LEPROSY

A chronic communicable disease, one of the most ancient of human maladies.

Incidence

Leprosy has for centuries been a disease much dreaded because of its destructive character. It has been observed in nearly all parts of the world. In the tropics the disease is still quite prevalent, notably in India, China, Japan, Philippine Islands, Hawaii, Mexico and certain of the West Indies. In Europe it is found, but much less commonly; in Norway, Sweden, Finland, Russia, Turkey, Spain, Italy and Greece. In the United States it occurs in the Gulf and Pacific Coast States among Orientals. There are only a few cases in Canada and almost all, among persons who have recently entered the country. No age or social group is exempt from infection. Since it is a chronic disease, it has no characteristic seasonal incidence. It is now endemic in tropical countries and sporadic cases occur elsewhere. It is no longer epidemic, although it is said to have been in Europe in the middle ages.

Etiology

The disease is caused by an acid-fast bacillus described by Hansen in 1874. The germ occurs in the lesions in the skin and elsewhere in enormous numbers. Sections of the skin stained by an acid-fast staining method reveal clumps of bacilli. Scrapings from the mucous membrane of the nose also show the germs.

Mode of Transmission

Mode of transmission is unknown. Probably prolonged and intimate contact is necessary for the transfer of infection but other factors also operate, the nature of which is as yet undetermined. The disease is chronic and in certain respects it resembles tuberculosis. Undoubtedly the very vigorous measures adopted in the past to absolutely segregate lepers may have favorably influenced the incidence of the disease by lessening opportunities for its spread. The source of infection is believed to be the discharges from the lesions. The incubation period may be weeks or months. The exact period is not known. It is believed that in communities where general sanitary conditions are good the disease is only slightly communicable.

Prevention and Control

Leprosy, of course, must always be reported, and in the United States and Canada, and in certain other countries lepers are segregated in colonies. In the event of a case requiring to be isolated pending removal to a leper colony, the patient should be kept absolutely apart, separate dishes, linen, etc., being provided and concurrent disinfection of discharges, etc., carried out. There should be thorough cleansing of such premises after the removal of the patient.

Federal public health authorities in the United States and Canada have supervision of lepers and they are cared for in special colonies. Just recently in the treatment of leprosy encouraging results have been reported; a summary of these was published in the Weekly Public Health Reports of the United States Public Health Service, August 20, 1920, Vol. 35, No. 34.

DENGUE: (SEVEN DAYS' FEVER, BREAKBONE FEVER)

Dengue is an acute communicable disease conveyed by a species of insect.

Incidence

Dengue occurs in tropical and semitropical countries. In the West Indies, Central and South America, Asia, the South Sea Islands, Australia, the Philippines, Southeastern Europe and the Southern United States, the disease is endemic and occasionally

epidemic, in limited areas. These epidemics arise suddenly, sweep over part of a country and quickly subside. The attack rate is high in such outbreaks.

Etiology

The exact nature of the cause of the disease is unknown. It is apparently an ultramicroscopic filtrable virus.

Mode of Transmission

Graham, in 1902, ascertained that a species of mosquito, Culex quinquefasciatus, conveys infection. Since that time, other species of mosquitoes have been incriminated including the vector of yellow fever, Aëdes calopus. The above species of culex is a domestic mosquito in the tropics. The distribution of the disease corresponds to that of Culex quinquefasciatus. The virus may undergo a cycle of development in the insect host.

Diagnosis

The disease has a very short incubation period, usually about two to five days. In the mosquito, forty-eight hours elapse after it has drawn blood from a case of dengue before it is able to transmit the cause of the disease. There is a very sudden onset with headache, high fever, severe pain in bones and joints and intense congestion of surface blood vessels. This condition persists for two days when the fever subsides; there is then, very often severe nose-bleed and sometimes diarrhea. A remission occurs of a few days' duration. There is next a return of fever, joint pains, etc., and a macular rash covers the body. This fades away after three to five days, and desquamation follows. Recovery may now be prompt, but often there are persistent pains in bones and joints for several weeks. Death does not result, in uncomplicated cases. One attack may confer an immunity.

Prevention and Control

Where the disease occurs, prevention (which means mosquito extermination and control) is at present almost impossible. Inadequate sanitary arrangements and the difficulty of completely protecting persons from mosquitoes where they are practically ubiquitous, explains why an epidemic of dengue rages almost unchecked,

once it becomes widespread. Antimosquito measures as carried out for the control of yellow fever or malaria are indicated, but because of the fact that the disease does not terminate fatally, are not likely to be adopted.

FILARIASIS

Filariasis is a disease which is most prevalent in tropical countries and is caused by any one of a number of species of filariae. These very small nematodes are parasitic in human beings. The first species of this worm to be identified was described by Bancroft in 1876, and is known as Filiaria bancrofti. The young forms of microfiliaria are found swarming in the peripheral blood, during the night particularly. The adult worms, filariae, are present in deep seated lymphatic vessels. Enormous numbers of persons in South China, in certain parts of Africa and the South Sea Islands harbor these parasites. Filarial worms give rise to the disease elephantiasis and the symptom chyluria. Sir Patrick Manson in 1879 demonstrated that certain species of mosquitoes transmit infection. The young worms undergo development in the insect hosts. Many species of mosquitoes may transmit filariae. Among these are species of anopheles, aëdes and culex. The prevention of filarial diseases can be accomplished by the application of antimosquito measures similar to those used in the control of malaria, yellow fever, and dengue.

TRYPANOSOMIASIS (SLEEPING SICKNESS)

A protozoan disease caused by a blood parasite, endemic in communities where the insect concerned in its transmission is found. Tropical West Africa, Uganda, and other parts of Central Africa, Rhodesia, Nyassaland, Portuguese East Africa and recently tropical Brazil have all suffered severely from the disease. Forde and Dutton in 1901 found a species of trypanosome, in the blood of a case of Gambian sleeping sickness. This is now known as Trypanosoma gambiense. There are several other species of the genus trypanosoma; these are T. rhodesiense (Kinghorn), T. nigeriense, and T. cruzi (Chagas). Sir David Bruce discovered that Trypanosoma gambiense is transmitted by a species of tsetse fly, Glossina palpalis. The Rhodesian type of sleeping sickness is transmitted by another species of tsetse fly, Glossina morsitans. Chagas' disease, which is

very prevalent in Brazil, is transmitted by a species of blood-sucking insect, Triatoma megista.

The prevention of all varieties of trypanosomiasis necessitates the adoption of various methods for the control or extermination of the insect carriers of these diseases. Much success has attended efforts directed to this end in various tropical communities.

RELAPSING FEVER

Relapsing fever is a very widespread disease, especially in tropical countries, caused by different varieties of spirochetes, the first of which was discovered by Obermeier in 1873. It occurs in other than tropical and subtropical countries. It is especially prevalent in such communities, however, where *it is usually a more serious disease.* Several species of spirochetes are known to cause infection, among these are Spirocheta recurrentis, Sp. duttoni, Sp. novyi, Sp. carteri, etc. Several different species of insects transmit these spirochetes. African "tick fever," caused by Sp. duttoni, is conveyed by a species of tick, Ornithodorus moubata. Other species of ticks have also been proved to be insect vectors of this disease. Nicolle and others have shown that head and body lice may also transmit relapsing fever. Salvarsan is a specific in the treatment of relapsing fever. The spirochetes of this disease are destroyed even more readily than are those of syphilis by this arsenical preparation.

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CHAPTER IX

DISEASES OF UNKNOWN ETIOLOGY, FOR THE MORE IMPORTANT OF WHICH THERE EXIST SPECIFIC METHODS OF PREVENTION. SMALLPOX, RABIES AND CHICKENPOX

The most important diseases of this group have ceased for the present at least, to be the great menace they were in times past. Further it lies within the power of any community, (because of advances in knowledge in regard to smallpox, and rabies) to control the first, and eliminate the second. The third in this group, chickenpox, is a minor communicable disease of childhood, and is chiefly important because it frequently gives rise to difficulty in diagnosis in cases of mild smallpox. Smallpox and chickenpox are sometimes very difficult to differentiate clinically. This is of considerable interest from a public health standpoint, because there is very little doubt that certain mild cases of smallpox will not be brought to the attention of the local public health authority, and in consequence, widespread epidemics of the disease may result.

SMALLPOX (VARIOLA)

Smallpox is an acute communicable disease, of unknown etiology; a method for control of which has been employed for more than a century.

Incidence

Smallpox has been recognized as a distinct clinical entity for hundreds of years. Descriptions of the disease by Rhazes, in the tenth century, are apparently the earliest in medical literature, though it was not then regarded as a new disease. It was very prevalent in Europe in the eleventh and twelfth centuries. It is believed that 60 millions of people died of smallpox during the eighteenth century. This seems to have been the time when the disease was at its height. Epidemics in Europe occurred in 1649, 1666, 1678, 1690, 1702, 1721, 1730, 1752, 1764, 1788, 1792 and the great pandemic of 1870-73 is within the memory of physicians still engaged in the prac-

tice of medicine. The next epidemic was in 1892-5 and another outbreak, the most extensive of recent years was that of 1902-5. The first outbreak in the Western Hemisphere was in 1507 in the West Indies. That was a most disastrous epidemic. Many tribes of natives were exterminated before the outbreak subsided. In 1520 Spanish troops carried smallpox into Mexico, where ever since it has been endemic. In the United States and Canada the most recent epidemic of considerable proportions, with a relatively high death rate was that of 1901-3. At that time in Philadelphia there were 7,204 cases and the mortality was 26.89 per cent. In Massachusetts in 1902, the mortality was 11 per cent. In other parts of the United States between the years 1901-3, there were outbreaks in which the death rate was as low as 2 per cent.

In the registration area of the United States, there were in 1919, 358 deaths from smallpox, a rate of 0.4 per 100,000 of population and it accounted for less than $\frac{1}{10}$ of 1 per cent of the total deaths. The experience of the Province of Ontario, during the fall and winter of 1919-20 is characteristic of what is at present occurring in many communities. During the summer of 1919 there were in the City of Toronto, a large number of cases of chickenpox reported. A few cases of smallpox were also notified. There were in addition quite a number of cases in which it was exceedingly difficult to decide whether they were chickenpox or smallpox. Most commonly perhaps, they were said to be chickenpox. At that time there were very few cases of smallpox in Ontario, outside of Toronto. Conditions for an outbreak of smallpox were favorable. A very considerable proportion of the population was unvaccinated or vaccinated more than ten years previously. In October two cases of smallpox were reported, but the explosive outbreak began in November. The record of that month, and those intervening up until March, 1920, is as follows:

SMALLPOX, TORONTO, 1919-1920.	NO. OF CASES
October, 1919	2
November, 1919	811
December, 1919	1,045
January, 1920	636
February, 1920	248
March, 1920	122
Total	2,864 cases
Total deaths	11

On March 31, 1920, there were only 48 cases of the disease in the City. The epidemic was over. In the meantime more than 200,000 people in Toronto had been vaccinated, much inconvenience occasioned and many foci of infection had arisen in other parts of Ontario. In the entire Province during the months of November to March, inclusive, there were 5,078 cases, of which 54 per cent were in Toronto. The total deaths in this series of cases was only 24. The outbreak was due to the fact that the population was largely unvaccinated, and it was checked because about 490,000 people in Ontario were vaccinated. While it was in progress a few misinformed and misguided individuals increased the difficulties of the situation by carrying on the usual vituperative and untruthful campaign against vaccination.

While the number of cases reported in October almost certainly did not represent the number of cases that actually developed during that month, it had a wider significance. Many mild cases were undoubtedly not seen at all by physicians, a few may not have been recognized, and the general indifference had its inevitable sequela. Many other communities in the United States and Canada have witnessed similar quite unnecessary outbreaks during the past five years. So long as smallpox continues to exact a small toll in lives, and the vast majority of persons in otherwise progressive communities remain unvaccinated, history will continue to repeat itself.

The remarkable reduction in the fatality of smallpox in England and Wales during the past half century is shown in the following table from McVail:

ENGLAND AND WALES: SMALLPOX DEATHS 1867-1916	DEATHS
1867-76	58,614
1877-86	18,026
1887-96	4,892
1897-1906	4,763
1907-1916	139

Table XLV indicates the number of cases of smallpox reported in certain States for the years 1916 and 1920 and indicates clearly the increased prevalence of the disease during the past few years. In Ontario during 1920 about 65,000 cases of communicable diseases of all kinds were reported. Among these there were 5,000 cases of smallpox, between 7 and 8 per cent of the total.

TABLE XLV

NUMBER OF SMALLPOX CASES REPORTED IN CERTAIN STATES FOR THE YEARS 1916 TO 1920

(Statistical Bulletin, Metropolitan Life Insurance Company, January, 1921.)

STATE	1920	1919	1918	1917	1916
California	4,503	1,992	1,069	329	234
Colorado	2,878	1,714	1,680	323	103
Illinois	6,617	3,971	3,842	4,996	....†
Indiana	6,775	3,620	5,582	4,593	1,158
Kansas	3,900	2,130	7,130	2,623	2,085
Louisiana	1,558	1,120	950	835	819
Maryland	176	212	219	98	69
Massachusetts	29	32	27	65	32
Michigan	4,848	2,885	4,417	2,929	1,365
Minnesota	5,447	2,280	2,252	2,718	1,270
Mississippi	4,148	2,511	3,601	1,530	1,401
Nebraska	4,135	2,861	3,906	....†	....†
New Jersey	181	66	65	6	9
North Carolina	2,961	1,880	899	....†	....†
Ohio	7,228	3,924	10,227	5,243	1,921
Oregon	2,828*	2,381	493	122	119
Pennsylvania	215	198	612	380	97
Texas	1,547	....†	4,338	1,350	....†
Washington	5,997	4,372	1,676	390	637
West Virginia	2,619	2,214	1,266	413	....†

*Up to November 30th only.
†No data available.

The prevalence of smallpox has never been shown to be dependent to the slightest extent on conditions of race, climate, soil or general sanitary or hygienic conditions. Vaccination and revaccination are the factors which influence the incidence of the disease in those places where it is endemic, as it is now to a greater or less extent in almost all countries of the world. The age incidence of the disease is of interest. In the period before vaccination was carried out, it was a disease of childhood. This was probably due to the fact that while all ages of unvaccinated persons are equally susceptible, very few adults escaped infection during childhood, and in consequence it was much more prevalent in the early age periods. Where vaccination and revaccination are systematically practiced, this is not the case. No one is naturally immune, but since there are many adults who have been vaccinated in early life, but not revaccinated, the disease is now somewhat more prevalent among adults. Force, in an epidemiological study of smallpox in California, has shown that in three years, 1916, 1918 and 1919, among a steadily increasing population of school children, smallpox has

tended to resume a characteristic it once possessed, and become primarily a children's disease. Figures as to the proportion of children vaccinated in different countries are difficult to obtain. Force in the article quoted above states that 80 per cent of school children in California are unvaccinated. Sir George Newman has pointed out that in England and Wales in 1917, the percentage of children successfully vaccinated was only 43.3 per cent, compared with 61 per cent in 1898. The percentage of exemptions in England and Wales in the same period has increased from 5 to 37.9. In the City of Toronto in 1920 there were 73,468 children registered in the public schools, among these 17,698 complete physical examinations were made during that year. Of this number (17,698), 13,480 were found to have been vaccinated, or about 70 per cent of those investigated. This high percentage is undoubtedly in large part accounted for by the general vaccination carried on during the epidemic of 1919-1920. It would seem that within another decade or two the unvaccinated children will outnumber the vaccinated by at least 2 to 1.

In addition to typical smallpox or variola, a condition known as varioloid or mild smallpox has for a long time been recognized. It develops most frequently in those who were vaccinated many years previously but have not been revaccinated.

Etiology

For many years it has been known that there exist in epithelial cells in the skin of persons suffering from smallpox, tiny inclusions which various observers regard as the cause of the disease. These were first seen by Weigert in 1874, and described further by Guarnieri in 1892. In 1902-03 Councilman and his collaborators studied these cell inclusions anew and worked out what they regard as the life cycle of a protozoan parasite. Because it is so regarded by them the name Cytorrhyctes variolae has been given to it. This view, as to the cause of smallpox, is not accepted by all, and it may still be regarded as an open question as to whether the etiological agent of the disease has yet been described. The virus of smallpox, whatever its nature, is not filtrable, is not especially resistant to drying, but will live for long periods in glycerine if kept at a low temperature.

Mode of Transmission

The exact method by which the disease is conveyed from one person to another is not yet known. The virus is certainly present in the lesions in the skin and mucous membranes. The disease may be transmitted during the pre-eruptive period, but not during incubation. It is believed to be most highly communicable during vesiculation and pustulation. The mouth and nose secretions from a case of smallpox contain the virus of the disease. Just how the causative agent is conveyed is a matter of dispute. It was formerly believed that the virus might be carried in the air and infection for considerable distances conveyed. This view has generally been discarded.

Direct contact with a smallpox patient, when virus from the mouth, nose, skin or mucous membrane lesions is transferred to exposed individuals, has long been known to result in infection. Similarly, if fomites wet with mouth, nose, skin or mucous membrane secretions are brought into contact with a susceptible individual, infection is conveyed. Contact, therefore, seems to be almost essential for the spread of the disease, that is contact with a case of the disease or secretions of the patient containing the virus. Air-borne infection outside the room or building in which the patient is confined, is now regarded as being very improbable. Man is the only source of infection in smallpox. Somewhat analogous diseases occur in animals, namely, horsepox, cowpox and sheeppox. If animals with any of these diseases transmit them to man, only a local disease results. It is generally believed that cowpox and smallpox are essentially the same disease, the one in man and the other in cattle. The virus which causes these two conditions may be the same, but manifesting different characteristics in man and lower animals.

The great sources of new cases of smallpox are the mild, abortive, ambulant, or unrecognized cases of the disease which are not isolated, or concealed cases where an effort is made to avoid quarantine. Many mild cases of the disease are extremely difficult to recognize and if, as is frequently the case, they are not at once isolated, may infect a number of other unvaccinated persons. It is not a water or milk-borne disease, and there are no chronic carriers of smallpox. The incubation period of the disease is about 14 days

as a rule. In many cases it is 10 to 12 days. Cases with an incubation period as short as 5½ and as long as 16 days have been reported.

Diagnosis

There follows the incubation period of a few days, usually 3, in which the patient is often very ill. This initial or pre-eruptive stage, which precedes the appearance of the rash, is usually of sudden onset. It is characterized further by symptoms of headache, vomiting, backache, chill and rise of temperature often to 104° F. The fever persists until the fourth day when all symptoms may subside, and the eruption then appears. A diffuse erythema sometimes precedes the appearance of the petechial rash which comes out on the fourth day. The rash, which at first is macular, usually appears first on the forehead, wrists and abdomen and then spreads. The macules are about 1 to 3 mm. in diameter, slightly indurated, hard or "shotty" and umbilicated. The macule develops into a papule and becomes depressed in the center, then a small grayish spot appears, this fills with liquid, forming a vesicle, and this appears usually about the seventh or eighth day of the disease, or about the third or fourth day of the eruption. Within the next two days the fluid in the vesicle becomes purulent, and on the eighth, ninth or tenth day the pustule is fully developed. This in a couple of days has reached its maximum. Coincident with the development of this lesion there is usually marked edema of the skin and subcutaneous tissue. This is especially marked on the face. The eyelids are partly closed, the face swollen, the lips thick and lesions may be seen in the mucous membrane of the mouth. The macules appear in crops, then papules, vesicles and pustules follow in sequence. One seldom sees the lesions in different stages of development at the same time, in a given area of skin, as is commonly the case in chickenpox.

About the twelfth day the "pocks" begin to lose their fluid contents. First those on the face and head and in the mouth, then those on the arms, and later, those on the trunk and lower limbs become dry. The crusts of the individual lesions in the skin fall off. Occasionally a large cast of the palm of the hand or sole of the foot is desquamated in one piece. Sometimes the lesions are deep in the skin, especially on the hands. These may be very painful. When the individual lesions

run together and coalesce much destruction of tissue results. The eruption is always more abundant in areas of the skin where there is, or has been, irritation. As, for example, on the neck, or about the wrists or ankles, or in other places where there has been pressure from garments. This may be caused by increased vascularity the result of such irritation. Many clinical types of smallpox may be observed, as, for example, discrete, confluent, hemorrhagic, purpuric, etc.

In addition to the clinical symptoms it is important to obtain in every suspected case of smallpox, information as to possible contact with a known case of the disease. Also, it should be ascertained whether the patient has ever been successfully vaccinated. A typical vaccination scar should be the criterion in any case in deciding this. Persons who have never been successfully vaccinated will sometimes give a history of having been vaccinated, adding; "it did not take." This, of course, means that the individual is unvaccinated. A history, confirmed by other evidence of recent (within five years) successful vaccination, in an individual suspected of having a mild attack of smallpox would be strongly presumptive, taken in conjunction with the rest of the chain of evidence, that the condition was chickenpox and not smallpox.

In such doubtful cases there is another method which may be used, to assist in clearing up the diagnosis. It consists in applying an observation, originally made by Jenner, that in the case of vaccinated individuals or those who had previously had smallpox, the application of a small amount of material (virus) from a case of smallpox, produces an area of redness about the site of application in the immune individual. Tieche in 1912 recommended this procedure as a method of differentiation of smallpox and chickenpox, and later communicated satisfactory results obtained by applying the method. In 1915, Force and Beckwith suggested a laboratory method of the diagnosis of smallpox, which is essentially that proposed by Tieche except that previously vaccinated rabbits are employed instead of vaccinated persons.

The details of the method are as follows: For control—a rabbit that has been previously vaccinated with vaccine virus is given an intradermal injection of a 1 in 10 dilution in physiological salt solution, of vaccine virus. The injection is made with a glass tuberculin syringe provided with a 26 gauge needle 10 mm. in length. The

total amount injected is between 0.05 and 0.1 c.c. Within 24 hours, an intradermal reaction appears at the site of injection. It is characterized by infiltration of the skin, (edema), redness and other indications of a localized inflammation. The area measures from 10 by 12 mm. to 25 by 25 mm. The height of the reaction is usually noted in about forty-eight hours. Then, after another day, the redness begins to fade and the infiltration subsides. This positive control experiment indicates that cutaneous allergy (sensitization) to vaccine virus, is present in the rabbit previously injected with vaccine virus.

The contents of pustules of a case of smallpox, emulsified and injected into the skin of a vaccinated rabbit give the same reaction as the positive control, outlined above; whereas the contents of a pustule from a case of chickenpox give a negative reaction. That is, no redness, infiltration, etc., follows. Force has used this in a considerable number of cases with very satisfactory results.

He summarizes his conclusions as follows: "Rabbits sensitized by vaccination with vaccine virus will give a marked intradermal reaction with smallpox vesicle contents, in from 24 to 48 hours, but will not give such a reaction with varicella (chickenpox) vesicle contents. The cutaneous allergy following the original vaccination was present for at least 8 months. The intradermal reaction was produced with smallpox material nine days after removal from the patient. A laboratory method to aid in the diagnosis of smallpox is therefore available to physicians and health officers, since vesicle contents may be shipped in capillary tubes to diagnostic laboratories, and there used for making intradermal tests on sensitized rabbits or guinea pigs."

Defries and Hanna, in the Research Division of the Connaught Antitoxin Laboratories, have utilized this method in a considerable series of cases and have substantiated the conclusions of Force as to the value of the procedure. These observers point out that at the point of injection of material from a pustule from a case of smallpox, there appears within forty-eight hours a distinct papule, in addition to the infiltration and redness, and they attach much importance to this. The papule appears only when specific variolous matter has been injected. This reaction was further controlled by injections of solutions of foreign proteins of various sorts, none of which produced the characteristic papule. This papule measured

about 5 or 6 mm. in diameter. Rabbits vaccinated two or three months previously may be used for the test. A small area of skin, on the back of the animal, is shaved, and the vaccine virus of suspected variolous (smallpox) matter is injected intracutaneously. In every case of suspected smallpox when the diagnosis is in doubt, it is wise for the physician to request a member of the staff of the local, provincial or state board of health to see the patient in consultation, and if possible this should be done on the day on which the patient is first seen. The diagnosis of smallpox really rests on clinical, epidemiological and laboratory evidence and some of this can be supplied, as a rule, only by the local health department. Of course, there are doubtless a number of mild cases of smallpox in which no physician is called and the occurrence of such will only be ascertained accidentally.

Prevention and Control

Every case of suspected smallpox should at once be isolated, the health department immediately notified, and the contacts vaccinated, or at least they should be strongly advised that this should be done unless they give satisfactory evidence of recent successful vaccination. The quarantine of contacts of cases definitely found to be smallpox is carried out by the local board of health, and such contacts are usually quarantined for a period of fourteen days after last exposure to infection. If the patient is treated at home the house is placarded. The room in which the patient is should have a minimum amount of furniture, etc., only such as is essential for the care and treatment. Aseptic nursing by vaccinated persons should be required, and if not feasible the patient should be sent to a hospital. In rural communities, and unorganized districts, special emergency arrangements for the hospital care of cases of smallpox may be necessary if there are any number of cases. Patients can be cared for quite satisfactorily in temporary hospitals, if there are facilities for cooking, sterilization, etc., in addition to living quarters for the personnel.

Concurrent disinfection must be carefully carried out. Mouth, nose, and mucous membrane discharges and secretions should be disinfected or burned. Before desquamation commences and until it is complete, skin lesions should be covered with vaseline or some

other bland substance and thus kept soft. All bed and body linen, and everything used by or brought into contact with the patient, should be disinfected before being sent out. Carbolic acid solution (1-20) may be used for this purpose. Every one coming in contact with the patient should wear a gown and probably a mask also. The hands and face should be washed after leaving the patient's room, after the gown and mask have been removed. Separate dishes, etc., are of course, necessary. Unused food must be burned. The room and its contents must be cleansed and disinfected after the removal of the patient. The exact procedure to be followed is usually specified and frequently also carried out, by a representative of the local board of health.

While all these measures are necessary, it is very important to remember that vaccination is the one essential in the control of smallpox. Physicians are required immediately to report all suspected cases of the disease, to isolate such and carry out other measures as above outlined to limit the spread of the disease, but they have in addition a great responsibility in educating their patients in regard to the necessity for, and the wisdom of, vaccination. This question will be dealt with more in detail in the next section.

Vaccination

By means of vaccination, that is, the application to an abraded area on the skin, of a quantity of the virus of cowpox (or vaccine virus), the condition known as vaccinia is produced. As a result of an attack of vaccinia, an individual is rendered immune to smallpox. Vaccinia is a disease in man characterized by a local lesion or "pock." There occur, in addition certain constitutional symptoms such as rise of temperature, malaise, headache, etc. Vaccinia in human beings, corresponds to the disease cowpox in cattle, and to certain cases of horsepox or "grease" in horses.

Long before the introduction of vaccination the procedure known as inoculation was practiced. This is said to have been carried out by the Brahmins in India, centuries ago, and possibly among the Chinese. Much evidence is available indicating that inoculation was widely practiced in Turkey during the eighteenth century. It was introduced into England by Lady Mary Wortley Montagu in 1721. Inoculation consisted in transferring the virus of smallpox

to the skin or some mucous surface of healthy persons and producing in them, as a rule, a much modified, milder type of smallpox. This was based on the observation that the virus of the disease when applied in this way, was reduced in potency or activity, and the individual had usually a mild attack of smallpox, as a result of which, he was subsequently protected from a severe attack.

It is said that among the Chinese, inoculation was effected by inserting a crust from the pustule of a case of smallpox into the nostril of the individual. The disease was then communicated by way of the respiratory tract. Inoculation was widely practiced in England during the eighteenth century. An excellent account of this appears in Copeman's Milroy lecture for 1889, "Vaccination, Its Natural History and Pathology." This practice was not unattended by serious consequences at times, and following the introduction of vaccination it was abandoned, and it is now, almost everywhere, illegal.

The practice of vaccination we owe to Edward Jenner, an English physician of Berkeley, Gloucestershire. Jenner while serving his apprenticeship with John Hunter learned that it was widely believed in the West of England, and especially in his own county, that persons who, as a result of their employment on dairy farms, happened to contract cowpox were in consequence protected from a subsequent attack of smallpox. On May 14, 1796, he put this notion to the test. He vaccinated a lad of eight years of age, James Phipps, by name. He inserted into two superficial incisions on the arm of the boy, matter which he took from a vesicle on the hand of Sarah Nelmes a dairy maid who had been infected with cowpox while milking. Phipps had as a result, a successful vaccination. In the following July, Jenner obtained matter from a pustule from a case of smallpox and inserted it in the same way into the skin of the arm of the boy. No harmful or untoward result followed and thus was it demonstrated that cowpox protects absolutely from smallpox. Jenner repeated the experiment on a number of other persons who previously had cowpox, and in all the result was the same. It is to be noted that at this time the inoculation of smallpox was still in vogue, so that Jenner did not attempt anything that was not generally sanctioned and common practice. This work of Jenner which is embodied in his book "An Inquiry into the Causes and Effects of Variolae Vacciniae," is a

monumental contribution to preventive medicine, and really marks the birth of the science of immunology, the specific prevention of disease. One hundred and twenty-five years have passed since Jenner gave his great discovery to the world, and in only one particular do current beliefs differ from his own, as to the merit of vaccination. Jenner concluded that a single vaccination conferred permanent protection. There is now evidence to prove that revaccination after a period of years is necessary in many individuals, to produce a permanent immunity.

Copeman has produced, in calves, the disease cowpox, by the inoculation of purulent material from cases of smallpox. Subsequently material from other calves vaccinated with matter obtained from lesions in the first series, produced in human beings the typical lesions of vaccinia or cowpox. As a result of these experiments it is believed that the virus of smallpox and cowpox have a common origin, the virus of the former undergoing certain modifications when passed through calves, as a result of which it becomes attenuated, and in consequence produces only a local disease. The virus of this local disease in calves when transferred to man as in vaccination, causes vaccinia or cowpox, also a local disease, and as a result he is protected from smallpox.

Copeman in summarizing his results writes: "I believe it can be conclusively proved that smallpox lymph by passing through the system of the calf can be so altered in character as to become deprived of its power of causing a generalized eruption while inducing at the site of inoculation a vesicle indistinguishable from a typical vaccine vesicle; and more important still, if it be shown that when transferred again to man, it has by such treatment completely lost its power to produce a general disease, it may fairly be asserted that cowpox, or rather the artificially inoculated form of the disease which we term vaccinia, is nothing more or less than variola (smallpox), modified by transmission through the bovine animal."

The condition following vaccination which is designated vaccinia, when a successful "take" is the result, runs the following course. An incubation period of three to five days follows the vaccination. Then papules appear, which afterwards become vesicles, then pustules, and finally these dry up and a "scab" forms. If the papules appear about the fourth day, the vesicles are fully developed about

the seventh and the pustules by the eighth or ninth. The local lesion reaches its maximum about the eleventh or twelfth day. The slightly umbilicated vesicle or pustule at its height, was likened by Jenner to "a pearl upon the rose leaf." This is the typical lesion. The scar, red at first, later turns white and is pitted. Jenner laid great stress on this. The skin round the lesions becomes red and swollen and the area painful. The skin may become quite indurated. The axillary glands are often swollen. Certain constitutional symptoms usually accompany the development of the local lesion, especially in previously unvaccinated adults or in those vaccinated many years previously. Young children rarely suffer from these symptoms. They are, malaise, headache, rise of temperature, pain in the limbs and occasionally nausea and vomiting. After the twelfth to fourteenth day the local lesion begins to subside and the pustule forms a "scab" which becomes hard and wrinkled and finally drops off.

As a result of such a successful vaccination, immunity results, due to the appearance in the blood of protective substances, which are able to neutralize the virus of the disease. Immunity appears about the eighth or ninth day after vaccination. Definite protection conferred by vaccination persists in the majority of persons for from five to seven years. In some it lasts throughout life. In others, revaccination after seven years confers a permanent immunity. There are a few individuals, however, who may require to be vaccinated 3 or more times before being rendered permanently immune.

Revaccination may differ from primary vaccination described above in certain particulars. That is, in a person who is revaccinated, one of four things may happen:

(1) The revaccination may follow the same course as the primary vaccination. In such an individual the immunity conferred by the primary vaccination has disappeared.

(2) The revaccination may have a shorter incubation period, run a briefer course and terminate within ten days or so. This is the accelerated reaction. This occurs in those also who still possess a slight degree of immunity, but not complete protection.

(3) A very slight lesion may result, after the incubation period of perhaps less than twenty-four hours, followed by the appearance of a small papule which does not become a vesicle or pustule. In

48 to 72 hours the lesion has begun to subside. This is called an immediate reaction, and indicates immunity.

(4) There may be only slight trauma at the site of vaccination and this also, when potent virus is used, and proper technic employed, indicates immunity.

The effect of vaccination during the period of incubation of smallpox is shown in Table XLVI.

TABLE XLVI

THE EFFECT OF VACCINATION DURING THE PERIOD OF INCUBATION OF SMALLPOX

On the First Day	Early in the Incubation Period 2nd to 6th days	Middle of the Incubation Period 6th to 8th days	Toward the end of the Incubation Period 9th to 14th days	During the Primary Fever, or Preeruption Stage	
Prevents smallpox	Smallpox is aborted	Varioloid or mild case	Smallpox not influenced	Smallpox not influenced	Variola
1	2 3 4 5 6	7 8	9 10 11 12 13 14	1 2 3	Eruption
	Period of Incubation of Smallpox—in Days			Primary Fever	
The vaccination takes.	The vaccination takes.	The vaccination takes 2 or 4 days before primary fever.	The vaccination takes and both affections run side by side	The vaccination does not take (?)	Vaccinia
		To produce the best results the vaccination should precede this period, so as to reach maturity before the onset of the primary fever. The vaccine vesicle reaches maturity about the 8th day.			

After the introduction of vaccination by Jenner, vaccination directly from calf to man, or in man from arm to arm was for many years practiced. In the arm to arm method the "scabs" from the arm of the vaccinated persons were taken and emulsified and this material was rubbed into an abraded area of the arm. This was followed by the use of ivory points on which the lymph taken from calves was rubbed. The lymph was allowed to dry on these small pieces of ivory and if kept at a low temperature the virus in the lymph retained its potency for some weeks. In 1891 Copeman introduced what is called "glycerinated" lymph. The great merit

of this is that the extraneous bacteria in the vaccine are destroyed, but the virus retains its activity for weeks if kept at a low temperature. Subsequently a mixture of glycerine and carbolic acid solution was introduced, and this is what is used at present for the preparation of vaccine virus.

The method of preparation as followed in the Connaught Antitoxin Laboratories is here given:

Healthy, young calves are taken and after careful preparation, cleansing, shaving, etc., the abdominal area is scarified and vaccine virus known as "seed" virus* is rubbed into the area so prepared.

After six days the entire area which has been vaccinated is covered with vesicles filled with clear or semipurulent fluid. The calf is chloroformed and after the area has been thoroughly and repeatedly cleansed, the vesicles and superficial layers of skin surrounding the individual lesions are removed with a curette. This mixture of epithelial cells, lymph and debris is known as pulp. This is then passed through a very fine bronze sieve and emulsified with 50 per cent glycerine and 1 per cent carbolic acid solution. This mixture is now called "green" virus. It contains many bacteria which were in the skin of the calf. The green virus is put in a refrigerator at a temperature of 30° F. and allowed to "ripen." At this temperature in the presence of glycerine and carbolic acid, bacteria are in a short time almost completely destroyed. After 3 or 4 weeks the vaccine is examined and if the bacterial count is reduced to a minimum and no gas-forming or pathogenic bacteria such as B. tetani are present, the vaccine is ready for test. In addition to agar plates to determine the number of bacteria per c.c. of vaccine, aerobic and anerobic cultures are made and laboratory animals are inoculated to ascertain whether any harmful toxic product of bacteria is present. If it is found that there are no

*The seed virus is obtained from the Bureau of Laboratories of the Health Department of New York City. It came originally from England in 1874. It has, therefore, been propagated in New York for forty-seven years. Its original source is believed by Dr. W. H. Park to have been a case of cowpox. It is now known as "human-calf-rabbit" seed virus, and is produced as follows: "Crusts are collected from healthy children about 19 days after vaccination. These are cut up and emulsified into a paste with boiled water. This humanized seed is then inoculated into a small area of a calf's abdomen. The pulp from this special area is separated, collected, and glycerinized. It is then tested bacteriologically and clinically. This bovine virus from human seed is now used to vaccinate rabbits. Five days after vaccination the pulp is removed with a curette, weighed and emulsified with a solution of glycerine (50 per cent) sterile water (49.5 per cent) and carbolic acid (0.5 per cent) in the proportion of 1 part of pulp to 8 parts of solution."—(Park.)

tetanus bacilli, or gas-forming microorganisms, or streptococci present and the injected laboratory animals remain healthy, thus establishing the purity of the vaccine, it is then tested to ascertain its potency. This is done on rabbits. A small area of the skin of the rabbit is cleansed and scarified and a quantity of a certain dilution of the vaccine virus is applied. After a few days, if there is a successful "take," the strength or potency, roughly, of the virus is ascertained. The vaccine is now ready for clinical use. Vaccine virus is suspended in glycerine and carbolic acid solution and these substances quickly destroy it if the temperature is raised. It should therefore, be kept cold, preferably on ice. No vaccine virus should ever be used after the expiry date which is always stamped on every package.

Vaccine virus obtained from calves contains a certain number of bacteria. These are germs that are present in the sweat and sebaceous glands, and hair follicles of the calves. The regulations governing vaccine virus production, such as those of the Hygienic Laboratory of the United States Public Health Service, stipulate, of course, that not more than a certain number of these may be present (they must not exceed 50 per capillary tube of vaccine), and no gas-forming bacteria, streptococci, or other extraneous species of pathogenic germs. In hundreds of specimens of vaccine examined in the Hygienic Laboratory of the United States Public Health Service not once were tetanus bacilli found. Much stress is sometimes laid by those opposed to vaccination, on the presence in the vaccine of skin staphylococci. They forget that even were the vaccine sterile, it would not be so the moment it is rubbed into the abraded area of the arm of the individual who is being vaccinated. There it at once becomes mixed with similar species of skin cocci. Vaccine virus if ripened until it no longer contains any bacteria loses much of its potency. Recently Noguchi has prepared vaccine virus by propagating in it the testicles of rabbits and calves. Such virus can be obtained free of extraneous bacteria, but it has not come into general use, apparently because it has been found to give a smaller percentage of positive "takes," after being kept under ordinary conditions for any length of time. A satisfactory virus kept at ice-box temperature should for a period of several months, give "takes" in 95 per cent of cases, in primary vaccinations. Failures in vaccination, (that is where there is not

a "take"), are usually due to the use of a vaccine that has lost its potency because out-dated, or because it has been kept at a high temperature, or finally because of improper technic. A physician should invariably use fresh vaccine kept at a low temperature and should not attribute failures to the vaccine, when unsatisfactory results follow if it has been kept under improper conditions. Laboratories preparing vaccine virus under standard conditions such as those laid down by the Hygienic Laboratory, only distribute vaccine which will give a very high percentage of positive "takes," if used when fresh and kept at a low temperature.

Method of Vaccination

The recommended method of vaccination is as follows: Cleanse the area to be vaccinated (the most satisfactory site is the outer surface of the upper arm opposite the deltoid muscle) carefully with soap and water, followed by alcohol. Break off one end of the fine capillary tube containing the vaccine. Push the broken end of the tube carefully but firmly through the neck of the small rubber bulb, contained in the package of vaccine, until it punctures the diaphragm in the neck of the rubber bulb, then break off the other end of the tube. Make two superficial, linear abrasions or scratches about ⅛ of an inch long and 1 inch apart, with a sterile needle, on the arm. Care should be taken in making these abrasions not to draw blood. There should be only a slight oozing of lymph. Hold the bulb between the index and middle fingers, place the thumb over the opening and expel the vaccine on the abraded areas. Rub the vaccine thoroughly into the incisions with the needle. Allow the virus to dry, and cover the area with a loose sleeve, lined with gauze or linen, or a pad of sterile gauze may be strapped with adhesive over the vaccinated area. Never use a shield. Until the vaccine begins to take there may be no need for any covering over the scarified area. Later a dressing of sterile gauze may be strapped on to protect the area, as soon as the lesions form. This should be changed daily if there is much oozing, and the area washed with sterile water, or sterile physiological salt solution. In changing dressings avoid touching the vaccine wound. If there is but little oozing and the dressing is clean, it need be changed but a few times.

Some of the Other Methods of Vaccination are:

1. *Drill Method.*—By using a small burr or Von Pirquet drill an abraded area is made on which the vaccine is placed.

2. *Puncture Method.*—On the cleansed area a few drops of vaccine are placed and several punctures are made through this, into the superficial layers of the skin. The needle is held almost parallel to the arm.

After vaccination or revaccination patients should always be directed to keep the arm scrupulously clean and to return if the reaction is very severe. Observations should be made if possible, in the case of revaccinations, at the end of thirty-six hours and after three or four days. If this is not done, an individual who gives an immune reaction and wishes a certificate will require to be revaccinated. After a primary vaccination, observation at the end of ten days, under ordinary circumstances, is sufficient. Patients may be instructed to return or notify the physician if the reaction is very severe.

The best time to do a primary vaccination is during the first year of life and revaccination between the ages of twelve and thirteen. Every physician should advise his patients in this matter, and strongly urge upon them the desirability of having all healthy children vaccinated in early life. Only the family physician can in many instances carry on the essential educational work in regard to the wisdom and desirability of early vaccination of all children who are in good health.

Failure to obtain a successful "take" does not indicate immunity unless the virus is potent and the vaccination carefully performed. If there is any doubt it should be repeated. Vaccination and revaccination systematically carried out will confer a complete communal protection against smallpox. Vaccination en masse in a time of epidemic is most undesirable. It is for the general practitioner consistently to endeavor to vaccinate all those in families of which he is the medical advisor and health supervisor.

As to the dangers of vaccination. The commonest, is infection of the area (or wound infection) as a result of the invasion of germs. This can be avoided if strict cleanliness of the area is maintained and the vaccine wound is kept aseptic as would any other wound if treated according to modern surgical principles. A vaccine wound should

be regarded in precisely the same light as any other wound, so far as the necessity for asepsis is concerned. Physicians should instruct their patients to take every care to avoid infecting vaccine wounds. Autovaccination occasionally occurs. This is due to scratching or pricking the finger and carrying the vaccine beneath the skin, or with the fingers transferring it to the mucous membranes of the mouth or nose, resulting in the appearance of a local lesion of vaccinia there. Vaccine may cause blindness if introduced into the eye. Tetanus has followed vaccination where the vaccine wound has been contaminated with dirt containing tetanus bacilli, in the same fashion as the contamination of war wounds with soil, was followed by tetanus. This does not happen if the vaccine wound is kept clean. Generalized vaccinia, that is an eruption over the entire body following vaccination, is very rare but does occur. Such a case was observed by the author during the recent war. A nursing sister was vaccinated in the ordinary way, and after the usual incubation period she developed a generalized, instead of the usual local, lesion of vaccinia. This was the only case recorded in about 500,000 vaccinations in members of the Canadian Expeditionary Force during the years 1914-1919. And it is worthy of note that among this great number there was not a single serious, untoward accident following vaccination. In over 10,000,000 vaccinations in the Philippines during the years 1905-1915, Heiser has pointed out that there was not a single death, or serious accident, or complication. It sometimes happens that certain conditions arise during the course of vaccinations, and those opposed to the practice, allege that vaccination is therefore responsible. There is no evidence to substantiate such claims. Purpura has occurred during the course of a vaccinia but on the other hand fatal cases of purpura hemorrhagica have repeatedly been described in persons not recently, if ever, vaccinated. Accidents of any sort, following vaccination, are exceedingly rare when proper after-care of the vaccine wound is insisted upon, and the vaccination is properly performed, and vaccine used which has been prepared in a laboratory where standards, the equivalent of those of the Hygienic Laboratory, United States Public Health Service, are maintained.

A very interesting situation in reference to infantile vaccination has arisen in recent years. Certain countries, states and provinces have vaccination acts, laws or ordinances. Many of these require

that vaccination be done in infancy, others before children can be admitted to school, etc. Since smallpox has become much less severe in type and less prevalent, much laxity in enforcing the vaccination laws, has developed. Furthermore, in some places no systematic law enforcement whatever is carried on. In others, there are special clauses in the acts or regulations, which permit those who make a plea of conscientious objection to the practice, to avoid being vaccinated, or having their children vaccinated. This clause has made it possible in many communities for a large unvaccinated population to grow up, just as absence of law enforcement has in others. Millard the Medical Officer of Health of Leicester, England, who does not believe in universal infantile vaccination, but the isolation of cases of smallpox *and vaccination of contacts when a case occurs,* is so often misquoted by antivaccinationists that the following quotation from an article written by him in the *British Medical Journal,* of April 19, 1919, is of interest: "In conclusion, in order to prevent misunderstanding as to just where I stand, allow me to make my confession of faith. Vaccination as a scientific operation for conferring complete though temporary immunity *upon the individual,* will live forever and will always remain an outstanding achievement to the credit of British Medical Science. It will always be of the greatest service in combating outbreaks of smallpox whenever such may occur, and it robs such outbreaks of their chief terrors. But infantile vaccination as a state institution aiming at the universal vaccination of infants has been living on a reputation largely based on prophecies now proved to have been erroneous; it is largely discredited by large masses of the population and is rapidly becoming obsolete. I submit that the time is ripe for the reconsideration of the question whether it is any longer really necessary."

It will be seen that the point at issue is not, does vaccination protect against smallpox? That is admitted. The question is this, does universal infantile vaccination confer more satisfactory communal protection than early recognition of cases and vaccination of all contacts? As a matter of fact, in many communities there is so little enforcement of vaccination regulations that only contacts and those others who desire it are vaccinated. The physician who urges parents to have their children vaccinated in early life may be assured that in healthy children no harm will ensue, and that they

will be protected for many years from a loathsome disease, and if revaccinated, will usually be protected for life. And of course, without vaccination no epidemic outbreak of smallpox could ever be checked.

Over and against the above views of Millard, the following is from an article by Heiser on the result of vaccination in the Philippines. "In the Philippine Islands for many years smallpox claimed 40,000 or more deaths annually. Upon the systematic vaccination of all inhabitants, province by province, the disease disappeared in the wake of the vaccinators. For instance, after the vaccination of the inhabitants of the six provinces in the vicinity of Manila which had an annual mortality of 6,000 from smallpox the deaths from the disease were reduced to insignificant numbers. In Manila with a population of over 250,000 not one death from smallpox occurred in a period of 7 years. It is of especial interest to note that between 1915 and 1919, when the vaccination of newborn children was not effectually carried out, the disease promptly reappeared and in the summer of 1918, 700 deaths from smallpox were reported in Manila alone."

Systematic vaccination and, in addition, early recognition, immediate notification, and isolation of all cases of the disease; with renewed activity on the part of physicians in explaining to their patients the merit of vaccination, constitute the duty of those engaged in the practice of both curative and preventive medicine, with respect to smallpox.

RABIES (HYDROPHOBIA)

Rabies, one of the most ancient diseases, was first described by Aristotle in 300 B.C. He believed that it was a disease of animals only. The word hydrophobia, derived from the Greek meaning "dread of water," was given to this condition because it was assumed that there developed in animals, with the disease, a fear of water. Rabies, from the Latin, meaning "rage" or "madness," was adopted because of the prevalence of the maniacal form of the disease in certain lower animals.

Rabies is an acute communicable disease to which man and all other mammals are susceptible. Primarily a disease of animals, the

virus which causes it is transmitted to man in the saliva of infected animals, when it comes in contact with scratches, or abrasions, in the skin or mucous membranes.

Incidence

The disease has been prevalent in all parts of the world, with the exception of Australia. In Europe, Asia, and America it has long been present. It has been observed as far North as Greenland, and as far South as the Philippine Islands. Rabies has been very prevalent in European Russia, France, Austria, Prussia, Belgium, Turkey, less so in Holland. It is practically extinct in the Scandinavian countries, and has on several occasions been practically banished from the British Isles. In North America it is found in Mexico, in nearly all States of the United States, and in at least two Canadian Provinces, Ontario and British Columbia.

Since it is primarily an animal disease it is interesting to note its prevalence in different species. In dogs it is much more commonly seen than in any other animal. From 80 to 90 per cent of all cases in animals occur in dogs. Cats, cattle, horses, swine, goats, wolves, jackals, foxes and sheep are other animals which occasionally develop the disease. Rabbits and guinea-pigs may be artificially inoculated with rabies. Wolves in certain parts of Russia and Austria are most commonly the animals carrying the infection.

There is no constant and characteristic seasonal incidence. It was formerly assumed that the disease was more prevalent in the summer months, especially among dogs. This is not the fact. Stimson has shown the seasonal variations in prevalence are not marked or constant in any direction, except that relatively fewer cases are seen in the last three months of the year. Where the disease is found at present it is usually present in sporadic form, with occasional epidemics among dogs especially, and occasionally, secondary cases in human beings.

During 1919 cases of rabies in animals were reported in the States of the United States as shown in Table XLVII.

In the Province of Ontario an increase or decrease in the prevalence of the disease in dogs is always reflected in the number of individuals bitten by rabid dogs and applying for the Pasteur treatment. The numbers for the past decade are shown in Table XLVII-A.

TABLE XLVII

RABIES IN ANIMALS, 1919

STATE	CASES REPORTED	STATE	CASES REPORTED
Arkansas	63	Maryland	43
Oregon	8	District of Columbia	16
Massachusetts	57	Rhode Island	5
Georgia	12	Minnesota	5
Indiana	62	Mississippi	74
Wisconsin	30	Total	375

DEATHS FROM RABIES IN MAN, REGISTERED, 1919

Colorado	1	Illinois	4	Missouri	5	S. Carolina	2
Delaware	1	Indiana	1	New Jersey	1	Virginia	1
Utah	1	Florida	2	Kansas	2	New York	7
Georgia	1	Maryland	1	Ohio	9	Washington	1
		Massachusetts	1	Oklahoma	1		
		Total......................45					

TABLE XLVII—A

PERSONS RECEIVING PASTEUR TREATMENT, PROVINCE OF ONTARIO

1911	200	1916	48
1912	64	1917	55
1913	49	1918	29
1914	39	1919	23
1915	52	1920	5

At the present time (1921) the disease is less prevalent in the United States and in the Province of Ontario, than for many years. In British Columbia it has disappeared.

Etiology

In 1903, Negri described certain bodies (now known as Negri bodies) in nerve cells which he described as the cause of the disease. In 1897 at the British Association Meeting, J. J. Mackenzie described cell inclusions in rabic brains which apparently were the same as those later described by Negri. While there is unanimity of opinion as to the specificity of Negri bodies (that is there is agreement that they are found in cells in various parts of the nervous system, in rabies, and in no other disease), there is considerable difference of opinion as to whether they are protozoan parasites, and the actual cause of the disease. Some observers believe they are inclusions which appear as the result of cell degeneration. The Negri bodies are round, oval or oblong in shape. They vary in

size from 18 μ to 0.5 μ in diameter. They present a hyaline-like cytoplasm containing one or two chromatin bodies. The cytoplasm is homogeneous and basophilic in reaction. The number of Negri bodies found in different cases varies. They are found in the large ganglion cells, most frequently in the cornu ammonis, in the cerebellum, in basal ganglia and occasionally in the spinal cord. The term "rabies virus" is usually applied to the nervous tissue of an animal suffering from rabies, that is, the specific cause of the disease in the medium in which it is found. There are two sorts of virus, "fixed" virus and "street" virus. These terms are explained below.

Mode of Transmission

The reservoir of infection is the dog as a rule, though occasionally, as pointed out, it may be some other lower animal. The virus (minute, living agent) which causes rabies is present in the saliva and salivary glands of the affected animal, as soon as the symptoms appear. The virus is conveyed in the saliva when the animal bites another animal or man. This virus, as a result of the bite, is introduced beneath the skin or mucous membrane, then finds its way along the nerve fibres, and ends in the ganglion cells for which it has a specific affinity. The symptoms of the disease are due to the deleterious action of the virus on the cells of the nervous system. The virus is found, in addition, in the thyroid, suprarenal and lachrymal glands, also the blood, urine, seminal fluid, and lymph have been found to be infected. The usual mode of transfer of infection, in human cases, is from an infected dog, as the result of a bite. However, transfer of saliva containing the virus may occur in handling a dog, if the individual has a break in the skin. Usually there is a history of having been bitten, or licked on the hands, face or other exposed part of the body by an animal showing symptoms of rabies. The incubation period varies in man and lower animals. In man it may be from 14 to 90 days, in dogs and cats 14 to 60 days; horses 21 to 90 days; swine, sheep and goats 21 to 60 days, cows 14 to 80 days, etc. Bites about the face and neck are most dangerous, and the incubation period in such cases is shorter than in others, because, in these, the virus has a shorter distance to travel to the central nervous system. Bites on other exposed parts of the body are next most serious. It has been found that in about

67 per cent of instances, those bitten by rabid animals develop the disease. In the remainder, the saliva has not been carried through the clothing, etc., beneath the skin. The three factors which determine the rapidity with which the disease will develop are: (1) The quantity of virus introduced. (2) The point of entrance of the virus. (3) The potency of the virus. This varies in different species and in different animals of the same species. In man, lacerated wounds resulting from bites, especially at the tip of the fingers, etc., where small nerve terminals are abundant, are especially dangerous. Where the skin is thick and nerves not abundant the result is likely to be less serious. Since dogs, etc., not man, harbor the virus of the disease, it is necessary to indicate the essential features of the disease in them.

Diagnosis—Rabies in Dogs

There are two clinical types of the disease in dogs, known as dumb or paralytic, and furious rabies, respectively. Usually within 20 to 60 days after having been bitten, the symptoms appear. The animal in the furious type of the disease is first sullen, refuses food, is restless, snaps at any one approaching, and shows a complete change in disposition. After a time pronounced restlessness is the main symptom; the animal wanders away, or runs aimlessly for a long distance, refusing food and water, snapping at any one or anything crossing its path. Frothing at the mouth may be observed, and general weakness; finally paralysis supervenes, and death takes place usually within 5 days. In dumb rabies, the period of restlessness and excitement does not develop. Instead the animal refuses food or water, and becomes very quiet, shows early paralysis and death quickly takes place. In human cases of rabies, the first symptom is often a feeling of oppression in the chest. This was the only symptom in a case observed by the author. A man of fifty, bitten on the nose twenty-eight days previously, by a strange dog. He complained, at the expiration of the incubation period, of being unable to swallow and he refused food and water. When first seen by me he stated that not only was he unable to swallow, but even the thought of swallowing caused great discomfort. His pulse was 80, regular and even, temperature normal, respirations about 24. Within 12 hours he became wildly maniacal, developed delusions of unfaithfulness on the part of his wife, and endeavored to inflict

bodily harm upon her. He was then sent to the hospital and died within forty-eight hours. Convulsions and delirium supervened before death.

The characteristic difficulty in swallowing is due to paralysis of the muscles of deglutition and it was this symptom that led to the designation, hydrophobia, being given to the disease, originally. It was erroneously assumed that it was fear of water that produced the symptom. Any food, or any thought of food, may give rise to what is at first discomfort and later convulsions. All reflexes are exaggerated, pupils are often widely dilated, delirium and vivid hallucinatory experiences are common. Fortunately there may be deep clouding of consciousness. The temperature rises to 102° or 103° F., the pulse irregular; general and complete paralysis ensues; and death in from three to four days, usually. The attack may last for only one day, or as long as fifteen days. Human beings may have either the dumb (paralytic) or maniacal type of the disease. Death from asphyxia results. In a second case already reported by me, the incubation period was forty-two days and the duration of the attack forty-eight hours.

All cases of rabies end fatally. Once symptoms appear, no treatment whatever is of any value.

Diagnosis

Any one bitten by a dog or any other animal suffering from rabies should have the wound cauterized at once, if possible, with nitric acid. This is probably of value even some hours after the individual is bitten. This cauterization does not, however, obviate the necessity for the Pasteur treatment, if the dog has rabies. The essential point is this, every possible effort should be made to secure the dog, or other animal, and have it kept under observation (not killed) for ten days. Have it tied up. It may simply be bad tempered, but if it has rabies it will be dead in less than that time, usually indeed in three to five days. In which event the animal's head should be sent to the nearest public health diagnostic laboratory, and a search for Negri bodies made. If these are found, the patient should at once begin the preventive treatment. The confirmation of the diagnosis of rabies in animals rests upon the laboratory examination and the demonstration of Negri bodies. The head should be packed in ice

in the summer, and when the animal is killed it should, of course, be done humanely and not simply by shooting it through the head, or by otherwise violently destroying the brain tissue. If the brain tissue is so disturbed, or is not fresh, it may be impossible to make the necessary laboratory examination.

The brain is examined by direct smear examination, confirmed, if necessary, by inoculation into a rabbit or guinea-pig, of some of an emulsion of brain tissue. With reference to the value of direct smear examination of brain tissue of rabid animals, Park writes "In any case, however, we may be reasonably certain that when the fresh material examined microscopically is negative, it is not a case of rabies."

In the event of the dog, or other biting animal, making its escape and not being subsequently found, if rabies is known to be present among dogs and other animals in the community, the person will be well advised to take the treatment. However, that is something the patient must decide. The first human case of rabies I saw, gave a history of having been bitten by a dog which was not afterwards found. His was a face bite, and because it had been cauterized, he decided not to take the Pasteur treatment although advised to do so by his physician. Undoubtedly in that case failure to act on the advice given cost the patient his life.

Prophylactic Treatment—Pasteur's Preventive Vaccine

Because of the mortality of those bitten by rabid dogs, Pasteur was led to study the virus of rabies, and, as a result, developed the method, now known by his name, for *specific prevention* (not treatment) of rabies.

Pasteur ascertained that the virus of rabies as it was found in animals that had died of the disease, varied in strength or potency. That is, equal amounts of emulsion of the brains of different animals, if inoculated into rabbits or guinea pigs, required varying lengths of time to cause death in the animals so inoculated. These injections were made subdurally under precisely similar conditions. He learned, furthermore, that passage through successive series of rabbits or guinea pigs exalted the virulence, and passage through monkeys lowered it. This was determined by variations in the length of the incubation period. Emulsions of stronger virus produced the

disease in shorter, and weaker virus, in longer periods of time. He designated the virus as it is found in the brains of dogs dying of the disease acquired in the ordinary way, "street virus." This varied in strength in different animals. But it was further ascertained that when "street virus," obtained originally from a dog, was passed through a series of rabbits (20 or more), the incubation period, and course of the disease became gradually lessened until it was reduced to seven or eight days, and then became stationary. Less than this it could not be shortened. This virus always causes a fatal issue in rabbits within this time, because the rabbit dies within twenty-four to forty-eight hours, as a rule, after the appearance of symptoms. This was called "fixed virus."

On the basis of Jenner's work, Pasteur conceived the idea of attenuating this fixed virus and using it as a vaccine. This he did. The spinal cord of rabbits that die of rabies, the result of the injection of fixed virus, removed under aseptic precautions are dried over caustic potash. As a result each day the cord becomes less virulent, and gradually and progressively its strength is lost, until about the ninth day the virulence is completely lost. Pasteur began by preparing emulsions of small pieces of the rabbits spinal cord that had been so dried for fourteen days, then for thirteen, etc., until pieces of spinal cords that were dried for only two days were being used.

Injections of these cord emulsions were given daily for a period of about three weeks. Experimental animals so treated were found, after a period of two weeks after the last injection, to have developed an immunity, and doses of active virus injected into them did not produce the disease. Then it was learned that because of the prolonged incubation period, that if protective injections were begun in animals five days after they had been given virus, they still did not develop the disease. They acquired an immunity before the completion of the incubation period. The method was then tried out and perfected in animals, and was finally tried in the case of human beings who had been bitten by rabid animals. It was entirely successful, and a slightly modified method is now used the world over for the prevention of rabies in human beings.

Pasteur Institutes in France, Belgium, Tunis, and many other parts of the world were established, to carry on the production of the antirabic vaccine. Now in addition, in many other laboratories,

where antitoxins, vaccines and serums are prepared the Pasteur preventive treatment is also made. The Hygienic Laboratory, of the United States Public Health Service, Washington, and the New York City Health Department send out the treatment directly, by mail, to local health departments and physicians with full instructions for administration, so that physicians may treat their own patients. Elsewhere, as in Ontario for example, treatments are administered in the Laboratories of the Provincial Board of Health. A more intensive scheme of treatment is now followed in many places. It requires twenty-one days for complete administration. The first inoculation is made with a piece of eight-day cord. Daily injections are given of an emulsion of a piece of rabbit's spinal cord ½ cm. in length in 2½ to 3 c.c. of sterile physiological salt solution. The injections are given subcutaneously. The skin of the abdomen is usually chosen as the site for the injections, 25 in all in twenty-one days.

The results of the Pasteur treatment have been most satisfactory. The mortality among those bitten has been reduced from 16 per cent to just under 0.5 per cent. Treatment must be started early otherwise failures may occur. Treatment must be completed and immunity partially or fully developed before the end of the incubation period. Fortunately this is prolonged, so that if treatment is begun within a few days after being bitten satisfactory results accrue. Immunity appears two weeks after treatment and persists for a variable length of time for two years or more, in many cases.

The effects of treatment are as a rule only slight, temporary local discomfort, which quickly passes off, local redness, soreness, etc., between the seventh and twelfth days of treatment, especially. Very rarely local paralysis has been reported. In an experience of several hundred treatments I have not seen any serious consequences.

The scheme of intensive treatment as outlined in *Hygienic Laboratory Bulletin* (U. S. P. H. S.), No. 65, with directions for use are shown in Table XLVIII.

Treatment at a distance from a laboratory has been rendered possible in recent years through the use of glycerinated virus. Glycerine may be added to the emulsion, and this shipped in a special container; or the rabbit cord itself, cut into pieces representing

TABLE XLVIII

SCHEME FOR INTENSIVE TREATMENT

DAY	CORD	ADULT	AMOUNT INJECTED		DAY	CORD	ADULT	AMOUNT INJECTED	
			FIVE TO TEN YEARS	ONE TO FIVE YEARS				FIVE TO TEN YEARS	ONE TO FIVE YEARS
	Injections	c.c.	c.c.	c.c.		Injections	c.c.	c.c.	c.c.
1	8-7-6=3	2.5	2.5	2.5	12	3=1	2.5	2.5	2.0
2	4-3=2	2.5	2.5	2.0	13	3=1	2.5	2.5	2.0
3	5-4=2	2.5	2.5	2.5	14	2=1	2.5	2.5	2.0
4	3=1	2.5	2.5	2.0	15	2=1	2.5	2.5	2.0
5	3=1	2.5	2.5	2.0	16	4=1	2.5	2.5	2.5
6	2=1	2.5	2.0	1.5	17	3=1	2.5	2.5	2.5
7	2=1	2.5	2.5	2.0	18	2=1	2.5	2.5	2.0
8	1=1	2.5	1.5	1.0	19	3=1	2.5	2.5	2.0
9	5=1	2.5	2.5	2.5	20	2=1	2.5	2.5	2.5
10	4=1	2.5	2.5	2.5	21	1=1	2.5	2.5	2.0
11	4=1	2.5	2.5	2.5					

single doses, may be sent in bottles containing glycerine. These pieces of cord must be emulsified by the physician using them. The latter method has been used in shipping virus from the Hygienic Laboratory to the state health officials, upon their request to the Surgeon-General, United States Public Health Service, Washington, D. C. It necessitates some technical skill in its preparation and use, and for this reason it is stipulated that the virus shall be administered under the immediate supervision of the state health authorities.

The bottles containing the virus are accompanied by the following directions, and copies of the schemata of injections:

Directions for the use of rabies virus shipped from the Hygienic Laboratory, U. S. P. H. S., Washington, D. C.

The virus should be kept until used up, in an ice box or other cold place. This material is perishable, and must not be kept on hand for future use. Each bottle contains the number of doses required, until further shipments are made, of cord dried for the number of days indicated on the label. Further shipments of cord to complete treatment already begun are made without further request.

Dose.—Each small section of cord (about one-half cm.) constitutes one dose. The following equipment is necessary for making and using the emulsion:

Physiological salt solution,
Alcohol,

Absorbent cotton or gauze,
Glass or porcelain mortar and pestle (capacity 10 to 20 c.c.),
Thumb forceps,
Hypodermatic syringe (at least 3 c.c. capacity) with large needle,
Glass pipette, 5 c.c. graduated at least to 0.5 c.c.,
Small conical test glass or beaker or other small container.

This must be sterilized, and the instruments, etc., rinsed in sterile salt solution. Aseptic technic throughout.

To Make the Emulsion.—Remove one section of cord from the bottle with the thumb forceps, and rinse it free of glycerine with sterile salt solution in the small glass container; place in the empty mortar, and, without the addition of any fluid, rub up as finely as possible. Then 2½ c.c. of the salt solution are gradually added by means of the pipette, taking care between the additions of salt solution to rub to a uniform consistency. Draw the full amount of the emulsion into the syringe.

To Use.—Scrub the skin at site of inoculation with alcohol, and inject the emulsion into the subcutaneous tissue, being careful not to injure muscular layers or visible veins. Alternate successful injections on the two sides of the anterior abdominal wall. For the schemes of injections see accompanying sheets.

A record should be kept of each case, giving essential particulars concerning the patient, his injury, treatment, and subsequent history, with dates; and also concerning the biting animal and the basis upon which the diagnosis of rabies was made.

General Methods of Control

Cases of rabies are usually required to be reported. Isolation of the human patient is only necessary for purposes of more satisfactorily caring for the case. The result is always fatal, and only symptomatic measures to lessen the patient's agony can be resorted to. Disinfection of saliva, etc., is necessary. Quarantine is not established.

Where the disease exists, registration, licensing or otherwise regulating the dogs in the community is necessary. Stray, ownerless dogs should be destroyed, all others allowed on streets on leash, or muzzled until the disease is brought under control. Then the detention and isolation of dogs being taken into the country to ascertain whether they have rabies is most valuable. The problem is really one of legislation to control dogs. Australia has never had rabies, because dogs are quarantined before being allowed into the country. Norway, Sweden and Denmark have in the same way avoided outbreaks.

In England, rabies among animals was very prevalent. Legislation was passed requiring muzzling, etc., for a time, and also quar-

antine of dogs entering the country. The following table shows the results obtained:

YEAR	CASES	
1887	217	No quarantine regulations or muzzling of dogs.
1888	160	
1889	312	
1890	189	Quarantine and muzzling required.
1891	79	
1892	38	

At this point, owing to sentimental objections, and on account of the activities of those opposed to rational public health measures, the regulations were repealed with the following results:

YEAR	CASES
1893	93
1894	248
1895	672

Here common sense dictated a return to the former policy with the result indicated:

YEAR	CASES
1896	438
1897	151
1898	9
1900	0

Muzzling is no longer necessary, but all dogs taken into England are held in quarantine for six months at the expense of the owner. Subsequently, if they do not develop symptoms of rabies the animal is released. Practically every community can eliminate this disease, entirely, by these means. Coupled with this, strict licensing and the removal of stray, ownerless dogs is necessary.

CHICKENPOX

An acute communicable disease, usually of childhood. While as a rule, it is not serious, sequelae, or complications, such as sepsis, erysipelas, pneumonia or nephritis, indicate that it may, in certain cases, be more than a minor transmissible disease. It also has considerable public health significance because of the fact that it may be confused with smallpox and under such circumstances, epidemics

of the latter disease may gain considerable headway before adequate steps are taken to control them.

Incidence

The disease may occur in a community, in the form of occasional sporadic cases, or it may manifest itself in endemic form, and occasionally in epidemics. These epidemics, unfortunately, may break out just before or after, or even during an epidemic of smallpox, in which event diagnostic difficulties are constantly presenting themselves to the physician. The disease is most prevalent among children, and the period of greatest susceptibility is between the ages of two and six years. It is quite uncommon among adults, although they are not necessarily immune because of a previous attack. An attack of smallpox or vaccinia does not protect from chickenpox. One attack of chickenpox, however, usually confers a permanent immunity to that disease.

Etiology

The cause of chickenpox is not known. The causative agent is believed to be in the skin and mucous membranes of those suffering from the disease. Apparently only human beings are naturally susceptible to infection. Attempts to inoculate monkeys with the virus of the disease have been unsuccessful.

Modes of Transmission

The disease is probably communicated, as a rule, by direct transfer of the contents of the lesions which appear in the skin and mucous membranes. The contents of the lesions when conveyed to susceptible persons in a moist state on articles, such as towels, etc., are believed in some instances, to be responsible for the production of the disease. The precise mechanism of infection in chickenpox, however, is obscure just as it is in smallpox. The incubation period of the disease has been observed to be as short as four days, and as long as twenty-one days. The average is probably from fourteen to twenty-one days. The disease appears to be highly communicable from the time the lesions first manifest themselves until they have completely disappeared.

Methods of Control

The patient should at once be completely isolated. Notification is also required. The management of the individual case, to prevent the spread of the disease, consists in early recognition and careful application of the principles of aseptic nursing accompanied by concurrent, and followed by terminal disinfection.

Since the differentiation of cases of chickenpox, and mild smallpox, often presents many difficulties, the physician will be well advised to ask a member of the health department staff to see the patient to confirm the diagnosis. If there is still a doubt, and especially if cases of chickenpox and smallpox are known to be present in the community at the time, the physician may request that a laboratory examination of the vesicle fluid of the patient be made. This will determine whether, if injected into the skin of a rabbit sensitized to vaccine virus, the fluid gives the reaction of smallpox virus, or no reaction at all, as is the case with chickenpox vesicle fluid. This procedure is described in detail in the section dealing with smallpox.

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CHAPTER X

VENEREAL DISEASES

Venereal Diseases: Syphilis, Gonorrhea and Chancroid; to which may be added ophthalmia neonatorum, which is very frequently due to gonococcus infection.

The major venereal diseases, syphilis and gonorrhea, may be called the third great plague, because this they literally are. It is not only that they are prevalent communicable diseases and are very serious from the standpoint of the individual patient, but they are also a very grave menace to the race. The burden inflicted on the state, directly and indirectly, as a result of the ravages of syphilis and gonorrhea are so enormous that it is literally appalling. This group of communicable diseases is an especially difficult public health problem because associated with them are certain special social and moral features peculiar only to them. Until very recently there has been a pronounced and almost universal tendency to avoid any reference to these diseases, and an ostrich-like attitude was the one most commonly adopted. Furthermore, those innocent and other than innocent suffering from the disease, were all stigmatized in the same fashion. There was, in addition, very often absolutely ruthless exploitation of sufferers by charlatans masquerading under false colors and dubbing themselves "specialists." This indeed they were, in the utterly shameless manner in which they frequently duped their victims, relieving them of considerable sums of money, and, often to no small degree aggravating the disease from which they suffered, through insufficient or improper treatment. Then added to this, self-medication was all too prevalent, often because of the brazen effrontery with which patent medicines of alleged therapeutic value were advertised in the newspapers and other periodicals. This, of course, was productive of much harm, and is very wisely, now prohibited in many communities.

Bound up with this problem of public health are economic issues of vast magnitude. Syphilis is one of the chief recruiting agents for the population of the hospitals for the insane. The volume of

insanity due directly to this cause may be as high as 10 to 20 per cent of all cases. Unfortunately such cases are nearly always a charge on the community not for a few days or weeks, but often for years before death ensues. Then, too, throughout the entire period of such an illness these patients are unproductive. Lowered efficiency among other sufferers from venereal diseases is also a matter of much moment. These are only two examples, of many, of this aspect of the question.

Then in addition to the medical, or public health, and economic, there is a social and a moral side of the venereal disease problem and they are all inseparably connected. Unfortunately, the moral aspect has at all times made the problem of control difficult, because ideas of crime and punishment have by some been confused with questions of eradication, or at least vigorous measures to reduce the prevalence of syphilis and gonorrhea. Undoubtedly the fact is frequently forgotten, that the great burden of these diseases falls usually on the innocent; women and children, born and unborn.

Fortunately a brighter era has dawned. Even before the War the gravity of the peril was beginning to be realized in Europe and in the British Isles, and it is to the lasting credit of the members of the medical profession, that in season and out, they sounded a warning note and emphasized the great need of organized community effort to meet the danger. In various Continental countries, societies for the purpose of enlightening the public were organized and the introduction of methods for lessening the incidence of venereal diseases naturally followed. In 1911, a Royal Commission on Venereal Diseases was appointed in Great Britain. This Commission reported in 1916, and the publication of this report coupled with the startling facts which were coming to light, as a result of the army medical examinations during the war, thoroughly aroused many people in high places. The careful stock-taking of man power, gave governments the world over great concern, and, plans were immediately laid to deal with the situation. Governmental action, voluntary organization, publicity on an unprecedented scale followed.

Every physician is concerned in this campaign against venereal diseases. It cannot succeed without his whole-hearted cooperation and assistance. As never before in the history of these diseases, it is of the utmost importance that medical practitioners should be

qualified to recognize, to treat, and to assist in the suppression of the venereal diseases. Quackery in relation to these conditions, and self-medication are being discouraged, and patients are turning to reputable physicians. It is the physician's duty to be prepared not only to diagnose and treat, but also to participate actively in official and voluntary efforts, having as their goal the prevention of venereal diseases.

From a public health standpoint very much depends upon this cooperation of physicians in private practice, because these diseases are now generally required to be reported. This is the duty that devolves upon the physician. Every case of syphilis, gonorrhea and chancroid should be reported, by number preferably (at the present time) to the proper public health authority. This may seem to some, unnecessary, to others a matter of indifference, and still others may feel it will not achieve the object in view. None of these mental reservations should for a moment deter the physician in the execution of his duty, and this is especially important at present, because unless notification is general and nearly complete, the *apparent incidence* of these diseases is going to be very much less than their *actual prevalence;* and it is this information that public health officials must have, when they appeal for appropriations to support diagnostic laboratories, establish and maintain treatment centers and carry on public health educational work.

A very excellent beginning has been made by legislatures and federal governments in many countries. It is just a start, however, and many other public health problems require solution, therefore it is in the interest of everyone that there should be complete data as to the members of these cases, the sex, age incidence, source of infection and other cognate factors, in order that appropriate funds for the purpose of carrying on this work be made available.

We are satisfied at present to accept the statement that only estimates and incomplete records as to incidence are now available. Later much more will be demanded, and it cannot be supplied unless physicians report every case treated. In addition to the need for complete data as to the prevalence of frank clinical cases of these diseases, there is need of much research and investigation to ascertain, not in limited groups of public ward hospital, or dispensary patients, but among large and representative groups in the community, the relationship of syphilis and gonorrhea to still-

births, prematurity, congenital debility (so-called, and one of the most common causes assigned for deaths in infants one month old and under) etc.; and the rôle that these conditions play in the production of diseases such as organic heart disease, atheroma, apoplexy and other important causes of death. Sweeping statements of a conflicting character are made as to the importance of syphilis as a cause of death. The fact is, we really do not know how important syphilis is in this respect. No generalization as to its being first, second, third or even tenth on the list of causes of death has any significance until there is concrete, trustworthy evidence forthcoming to enable us to place syphilis where it really belongs on the list. No one doubts that the present figures are untrustworthy, and even skeptics are prepared to believe it is much more significant than any Registrar-General's Report would lead one to suppose. We need, then, to know in every case, is syphilis a factor in the etiology of the condition? And then, in every fatal case of illness where there is a possibility that it may be a secondary or contributory cause of death, the fact should be so stated, in the death certificate. After all, none of these are very exacting requirements. Free diagnostic laboratory facilities are available almost everywhere, and it is always in the interest of the patient, the patient's family, and the community, to know if and when syphilis exists. And in the last analysis, only by complete, systematic and very general cooperation of all members of the profession, can these facts be learned and then recorded. Therefore, it is the physician's duty to report every case of these diseases, and, as far as possible ascertain by laboratory as well as clinical investigation, whether syphilis is a factor in causing death in any case where such is a possibility.

Syphilis and gonorrhea are the major diseases in this group, chancroid of much less importance, and perhaps the only one of them quite properly designated a venereal disease. Very many cases of syphilis and gonorrhea are not the result of venery or sexual intercourse, and this is so well understood that a group of cases of extragenital origin is always recognized. Then too, all the cases of congenital syphilis, of gonorrheal ophthalmia, etc., are not venereal in the ordinary interpretation, which is understood to be the result, in as far as these diseases are concerned, of irregular sexual intercourse. If we so regard it, then there would be added to the extravenereal infections, all those cases where an individual

develops the diseases as a result of the transfer of infection from husband or wife, as the case may be. It would probably be very much better if the terms, venereal diseases, social diseases, etc., were dropped, and instead the words syphilis and gonorrhea used. This is especially desirable and would not necessarily involve any more publicity of other than a desirable sort than there now is regarding these conditions. Publicity as to how these diseases are acquired and spread, and how they may be controlled is imperative, and no name or designation is as good as the one that cannot be misunderstood or misinterpreted. With practically a complete reversal of attitude in regard to syphilis and gonorrhea, a change in regard to the question of sex hygiene is necessary.

Children and young adults should not learn the essential facts relating to sex matters and those of sexual hygiene through channels which may be most undesirable. Parents first, teachers afterwards should instruct the children, and then spiritual guardians will have much better and more desirable material in which to implant or strengthen those ethical and moral conceptions, without which this teaching may not only be ineffective, but productive of more harm than good.

SYPHILIS

Syphilis is a communicable disease usually of chronic character, most frequently, but not always, acquired as a result of irregular sexual intercourse. It occurs not only as a disease entity, but is also an essential factor in the development of certain organic diseases of the central nervous system such as paresis (general paralysis of the insane) and tabes dorsalis (locomotor ataxia). Similarly, certain degenerative diseases of the arterial system are, in all probability, secondary to an antecedent syphilis.

Incidence

All the present data and opinions as to the prevalence of syphilis are really but estimates. Of these there is no lack, and if the same zeal is shown in ascertaining the exact prevalence, as is manifested in hazarding opinions as to probable incidence, then within a decade some worth while evidence on this point may be available. Vedder in his book on "Syphilis and Public Health," which every student

of this question should consult, gives no less than 143 references to articles in the current literature, on the prevalence of syphilis to the end of 1917. Estimates have been based on clinical and laboratory data and have been obtained, not for the community as a whole, of course, but from special groups and for certain age periods, sex, race, etc.

The first group to be considered is prostitutes, 50 to 100 per cent of those examined had syphilis. Among the insane, in institutions in the United States, the prevalence has been found to be as low as 9 per cent and as high as 25. In Canada something under 8 per cent of syphilitics have been found in institutions for the insane where surveys have been made. Vedder believes that in institutions for the insane an estimate of 15 to 30 per cent would more nearly represent the actual prevalence. Wassermann examinations done as a routine on adult admissions to hospitals and dispensaries for medical and surgical conditions, have revealed percentages as low as 6, and as high as 36, of all public ward patients. The social status of those admitted and the care and thoroughness with which examinations are made account for the variation in percentages. Among private ward patients the range has been from 4 to 15 per cent. In hospitals for sick children between 3 and 10 per cent have been found to have syphilis. Among criminals, 20 to 40 per cent are positive, according to Vedder. Lower percentages are reported in Toronto, by McClenahan (in 1299 cases there were 130 with a positive Wassermann reaction) and in Edmonton by Orr. Among healthy men, the percentages have been found by various observers to be as low as 2, and as high as 20 per cent. Among healthy women, figures are available only for presumed healthy women in maternity hospitals, in cities. Among them from 3 to 20 per cent have been found to be syphilitic.

Dr. Douglas White, before the British Royal Commission, estimated that there are something like 110,000 new syphilitic infections annually in the United Kingdom; and that altogether there must be about 3,000,000 syphilitics in the United Kingdom. This is an estimate, and only time will reveal its relation to the actual incidence. Factors influencing prevalence, are *age, marital condition, education, social status, early training,* etc. Data as to relative prevalence in urban and rural districts in the United States and

Canada is at present very meagre. The disease is prevalent in nearly every part of the world, and syphilization seems to be an inevitable concomitant of civilization.

Etiology

Syphilis is due to the invasion of Treponema pallidum, (Spirocheta pallida) as was first demonstrated by Schaudinn and Hoffman in 1905. Metchnikoff and Roux in 1903 showed that syphilis could be transmitted to higher apes (chimpanzees), and in 1905 found that animals so inoculated, could be protected by the application of mercury ointment, three-quarters of an hour after inoculation. Later an ointment of 10 parts of calomel and 20 parts of lanolin was shown to act in the same way.

Modes of Transmission

The incubation period of syphilis is about three weeks. The method of transfer of infection is by direct bodily contact with the individual suffering from syphilis, and in a stage of the disease when the Treponema pallidum may be conveyed from the infected person to the contact, or, indirectly, through fomites by contact with *moist* secretions from lesions of a syphilitic. As soon as such secretions have dried, they are no longer sources of infection. The causative organism is sensitive to extremes of temperature, to light, drying, and to disinfectants.

Primary lesions (chancres) are highly infectious from first to last. They contain enormous numbers of spirochetes. "It is one of the lesions of syphilis most frequently responsible for the transmission of the disease." (Vedder.) The secondary lesions, especially mucous patches, contain many treponemata, and like all syphilitic lesions containing them, are sources of infection. Any other secondary lesion containing the microorganism may also be the starting point of a fresh case of syphilis. It is early secondary syphilis that is a special source of danger. Vedder believes it is probable that the majority of cases of syphilis arise as a result of contact with primary or early secondary cases of the disease.

Tertiary syphilis is a much less common source of infection, and it is so because the Treponema pallidum is not found in the same numbers in tertiary lesions as in primary and secondary. But any

tertiary lesion in which there are germs of syphilis is a potential source of infection. Blood and other body fluids are capable of transmitting infection.

Syphilis transmission is classified as follows by Vedder:

A. *Syphilis insontium* or syphilis of the innocent
   1. Marital Syphilis.
   2. Hereditary Syphilis.
   3. Syphilis sine coitu, manifested by extragenital chancres.

B. *Syphilis pravorum*
   1. Adulterous relations.
   2. Clandestine prostitution.
   3. Open prostitution.

Marital syphilis is very frequent and of great importance. It includes all cases of transmission of syphilis from husband to wife or vice versa. This is a potent factor also in the causation of hereditary syphilis. The disastrous effects of syphilis upon the unborn child are indicated by the following extract from a report by Vedder:

"In 331 pregnancies in 100 syphilitic families 131, or 40 per cent, died before term; 51, or 15 per cent, died after birth; a total mortality of 55 per cent, 116 or 35 per cent are living but syphilitic and 33 or *10 per cent only* are living and free of syphilis. Marital syphilis in the vast majority of cases is conveyed from husband to wife. The reverse does occur, but undoubtedly very much less commonly.

Innocent extragenital infection, accounts for from 5 to 10 per cent of all cases of syphilis. Physicians, dentists, nurses, attendants, etc., constitute a large proportion of cases of extragenital infection. Vedder concludes "the great majority of cases of marital syphilis, hereditary syphilis and even extragenital infections are derived from men already infected from some other source." This other source is the prostitute, street or clandestine. Probably 90 per cent of syphilitic infections are so acquired. This is a matter of great importance in the prevention of both gonorrhea and syphilis.

Prevention and Control

Measures to lessen the incidence of syphilis may be considered under the heading of (a) community and (b) individual efforts.

The former will be dealt with in the section dealing with clinics for venereal diseases.

Individual Control and Personal Prophylaxis: Early Diagnosis

The early diagnosis of syphilis is of great importance from the point of view of the patient and the community. It should be realized that syphilis may with certainty be determined before the primary sore has taken on the characteristic clinical appearance of a chancre. Examination by dark-field illumination of smears made from scrapings of the spot renders this possible. Such sores, if of syphilitic origin, contain treponemata very early in the development. There is no necessity to await the development of a positive Wassermann reaction to aid in the diagnosis, in many cases. The earlier the diagnosis is made, the sooner the patient can be rendered noninfectious by means of vigorous treatment. Owing to the fact that a great deal of public health publicity work is being done to educate people generally in regard to the menace of venereal diseases, many persons, may, soon after exposure, apply to the physician for early treatment, or the application of prophylactic measures.

While there are very great differences of opinion among those engaged in the work of combating venereal diseases as to the wisdom of issuing prophylactic packets, so-called, for self-medication immediately after sexual intercourse, where infection may have resulted, there is no question whatever as to the desirability of physicians being prepared to give treatment to any patient at the earliest possible moment after exposure. It is now being made widely known, that the sure and certain way to avoid syphilitic infection is to refrain from irregular sexual relations. In this way, for more than 90 per cent of the cases, lies prevention. The extragenital infections would also be greatly reduced as a direct consequence. However, it seems at the present time that a very considerable number of persons will continue to expose themselves to the risk of syphilitic infection despite all educational and other efforts. For such, recourse to early treatment is highly desirable.

If within twelve hours after exposure to infection, men apply for treatment, the following procedure, recommended by Ledbetter may be followed: The entire penis and scrotum should be scrubbed

thoroughly with liquid soap and water for several minutes, and then washed with a 1-2000 solution of bichloride of mercury. If there are any abrasions they should be sprayed with hydrogen peroxide. The patient is then placed in a sitting position in a chair in front of a convenient receptacle, and given two injections of about 15 to 20 minims of a 10 per cent solution of argyrol. He is requested to retain each injection in the urethra for five minutes. Also a very small swab of 10 per cent of argyrol solution on a small wooden stick is inserted about half an inch into the meatus and retained for about three minutes; this should disinfect the portion of the urethra protected by the nozzle of the syringe. After these injections have been expelled, the penis and scrotum are thoroughly anointed with a 33 per cent calomel (in lanolin) ointment. The patient is advised not to urinate for at least two hours after the treatment and to allow the ointment to remain on the penis for six to eight hours. Temporary gauze dressing, should be applied to protect the patient's clothing.

The earlier the patient receives treatment after exposure the more effective it is, of course. In armed forces, such as the Army, Navy, etc., this treatment may often be undertaken four, six, or eight hours after exposure; this is much less likely to be possible in civil life. Patients who come for early treatment should be strongly advised to refrain from sexual relations pending the outcome of the exposure to infection, and it is advisable also to have them return for further examination within a month. The value of methods of early treatment is elaborated by Otto May in his book on the "Prevention of Venereal Diseases."

Patients who have not obtained early treatment and who are seen by the physician when a primary lesion may be developing should be carefully examined clinically, the history elicited, and the suspected sore carefully cleansed with sterile physiological salt solution or 50 per cent alcohol. Next with a sterile needle the sore should be carefully and gently abraded in such a fashion that there will be slight oozing of serum, but no bleeding. If the physician has the proper equipment he should now make an examination of a few drops of this serous exudate, mixed with a drop of sterile salt solution, on a clean glass slide, by means of a dark field. If such equipment is not available the serum and salt solution may

be placed on a slide, and if a diagnostic laboratory is at hand, carried there at once for examination. If laboratory facilities are not convenient, smears should be made on clean glass slides by mixing a drop of exudate with a drop of salt solution. This must be spread carefully in a thin film, allowed to dry in the air and then sent to a laboratory for examination, or it may be fixed in absolute alcohol. If the physician himself has a microscope and has facilities for examining stained smears, Fontana's method as outlined by Harrison is of great value.

It is necessary if the patient is not seen during the primary stage of the disease, perhaps because the initial sore has escaped observation, not only to take a history, make a careful physical examination, but also draw blood for a Wassermann test. This should be done when the patient is first seen in suspected secondary syphilis. If the diagnosis is positive or even suspicious, pending definite decision, treatment may be started if blood has been taken for the Wassermann test. Nearly all laboratories making such examinations furnish containers in which the specimen may be returned to the laboratory.

When the diagnosis is made the patient should be urged to advise the person by whom he was infected to consult a physician and obtain treatment. This is most essential from a public health standpoint. Then, too, any and all persons whom the patient may have infected should also be advised by the patient to consult a physician, or to go to a venereal disease clinic for examination, and take treatment if necessary. All cases must, of course, be reported to the health department, usually by number, and should be carefully instructed how to avoid infecting others. Vigorous treatment of primary lesions quickly renders them noninfectious. But patients must refrain from sexual intercourse and, if possible, unless they are prepared to follow explicitly the directions given, are often wiser to go to hospital during the height of the period of infectivity. If they do not, they should exercise every possible care to avoid the transfer of secretions, discharges, etc., containing the Treponema pallidum. Separate dishes are necessary, and should be boiled after being used. Personal and bed linen should be disinfected by boiling, or by soaking in 1-1000 bichloride of mercury solution for several hours. Separate urinals and latrines are necessary for syphilitic patients.

Every patient must continue treatment until no longer able to transmit infection to others. This is now required by law in very many communities. But the physician by simply explaining to the patient the desirability, from his own standpoint, of continuing treatment as long as is necessary, usually does not require to resort to legal measures. The patient should be given a card of instructions outlining exactly what he should do and the methods to be followed to avoid transmitting infection. It is especially essential that persons should be excluded from preparing or serving food while suffering from syphilis in the stage when they might convey infection to others.

Syphilis is communicable as long as there are open skin, or mucous membrane lesions, in the secretions of which there are treponemata. The time will vary in different cases. Careful clinical and laboratory examinations of blood, lesions, etc., are necessary in every case to determine when the patient is no longer likely to transmit the disease to others. Physicians should be familiar with the laws and regulations governing the control and prevention of syphilis which have been enacted in their own state or province.

GONORRHEA

Gonorrhea is a communicable disease transmitted by contact infection, and most frequently in adults, by sexual intercourse. Gonorrhea and Syphilis were established as distinct disease entities by Ricord.

Incidence

It is very generally considered that gonorrhea is more prevalent than syphilis. In 1920, there were in the United States, 427 venereal disease clinics operating under the joint auspices of the United States Public Health Service, and State Departments of Health. During the months of July, August, and September, 1920, there were reported 91,195 cases of venereal diseases. These were made up of 36,824 cases of syphilis 50,808 cases of gonorrhea and 3,563 cases of chancroid. This would, of course, not take into account the great number of cases that were not seen by physicians and not reported. Stokes, in discussing the prevalence of gonorrhea, points out: "Morrow and Forcheimer, on the basis of large experience

with the condition in the United States, propose figures varying from 51 to 60 per cent of the adult male population as having had the disease.'' Forcheimer further states that 20 per cent of those infected have acquired the disease before their twenty-first year, more than 60 per cent before their twenty-fifth year, and more than 80 per cent before their thirtieth year is past. Equally large estimates are given by various well-informed Europeans, notable German observers, such as Blaschko, Erb, and Pinkus. Getting at the matter indirectly, figures drawn from recent army experience indicate that gonorrhea is from four to five times as prevalent as syphilis. A very widely accepted estimate of the prevalence of syphilis is 10 to 13 per cent of the adult male population, so that a possible prevalence rate for gonorrhea of from 40 to 60 per cent is not unreasonable. Estimates of the amount of active gonorrhea acquired by a large group of men in a given time, can be obtained from the reports of the Surgeon-General of the United States Army. In 1907, under an inadequate system of examination, the admission rate (proportion of men admitted to sick list) for gonorrhea, was about 12 to 13 per cent, of the enlisted personnel. In the army the percentage has fallen steadily to between 5 and 6 per cent in 1915-16, owing to the efficacy of prophylactic or preventive methods introduced since 1911. The male civil population, which is not protected by safeguards that surround the army, probably has a prevalence approaching the army rates during our recent mobilization. Chronic gonorrhea often escapes inclusion in statistical estimates, because it is not brought to the attention of physicians or medical officers.

Gonorrhea is estimated to be sixteen times as prevalent in men as in women on the basis of statistics which cannot, however, be accepted as conclusive. The lowest estimate quoted, and one which is undoubtedly too low, is probably that of Erb, who maintained, a number of years ago, that only 5 per cent of 400 women whose husbands had had gonorrhea, acquired the disease themselves. No direct estimates of value exist, relative to prevalence in women, but an indirect conception may be obtained from the fact that 50 per cent of absolute and one-child sterility is due to gonorrhea in women. The percentage of gonorrhea in women varies largely with their social status. Among the most refined types of unmarried

women and girls it is probably negligibly small. Of the pregnant women in the public hospitals in a number of Continental cities, 20 to 25 per cent were said to have had gonorrhea. Prostitutes, professional or occasional, nearly all have it. The estimated prevalence of the disease in these types, ranges from 70 to 95 per cent, as determined by various investigators, and by studies of delinquent women, such as that of Haines, who found percentages ranging from 75.7 to 98.2 in 500 cases.

It must be more than apparent, in spite of the obvious difficulty in interpreting figures which contain so large an element of speculation, that gonorrhea offers to the sanitarian a problem of the first magnitude. It is in very fact, one of the commonest of all diseases. It wholly outranks the large majority of infections such as scarlet fever, smallpox, and diphtheria, and even runs a close second to measles, the most contagious disease that affects mankind.

Watson in his statement before the Canadian Commission of Conservation in 1917, in discussing gonorrhea and its sequelae stated that "out of a total of 329 operations performed in the Gynecological Department of the Toronto General Hospital during the past year, 40, or over 12 per cent, were undertaken for the relief of conditions directly due to gonorrhea infection. When we take account of major operations only, 25 per cent were performed for gonorrheal complications. These figures do not differ materially from New York Hospital statistics. They take no account of the number of patients who recover without operation.

"The classes of women suffering from the disease are prostitutes, feeble-minded, domestics, clerks, and married women. It is an important fact to note that of the 40 cases I mentioned as requiring major abdominal operations for gonorrheal infection 28 were married and 12 single. The married women were in nearly every case, innocent victims of infection conveyed by their husbands. The latter too, in many cases were innocent to the extent that they believed themselves to be no longer infected. Had they been placed under a proper system of treatment and control, and been warned of the danger of their condition, their wives would have escaped.

"The tremendous importance of all this lies in the fact that gonorrhea in the female is a very serious condition, much more so than in the male. It is serious from the following points of view:

"(a) The disease tends to spread from the primary site of infection up into the uterus and into the fallopian tubes and so to the peritoneal cavity, a condition of affairs which puts the patient's life in jeopardy. If she recovers, it is often only to lead the life of a chronic invalid or to have to submit herself to an extensive and mutilating operation which renders future childbearing impossible.

"(b) Apart from the above severe complications sterility very often results from milder attacks. Probably 50 per cent of all cases of sterility in the female are directly the result of gonorrheal infection. From the point of view of the conservation of the race, this is one of the most serious aspects of the question.

"(c) In the female the disease often assumes a latent form which is extremely difficult to recognize. Treatment is difficult and it is not easy to be sure when cure is effected. The possibilities of spread of the contagion from the individual female are thus very much greater than from the individual male.

"(d) If a woman be suffering from gonorrhea at the time of labor, her child runs a great risk of developing ophthalmia; 40 per cent of all cases of congenital blindness are due to this cause.

"A consideration of these facts shows that great loss to the state results from gonorrheal infection; a loss expressed by:

"(a) The diminishing working capacity of the individual and the frequent necessity for maintaining her in hospital or elsewhere.

"(b) The diminishing birth rate.

"(c) The birth of permanently disabled children."

Etiology

The cause of this disease is the Micrococcus gonorrheae (gonococcus). This was proved by Neisser in 1879. This germ has an especial affinity for mucous membranes.

Modes of Transmission

The sources of infection are the discharges from the mucous membranes or glands in the genital tract of persons harboring gonococci. The incubation period of the disease is from one to eight days; most commonly three to five. Gonorrhea is most frequently acquired, in adults, by direct contact in sexual intercourse. As in syphilis, so too in gonorrhea, prostitutes, regular or clandes-

tine, play a very important rôle in the spread of the disease. Indirectly, through fomites, gonorrhea may develop as a result of contact with articles of clothing or towels, freshly soiled with secretions from a case of the disease. This latter is especially likely to be the method of spread in cases of gonorrheal vaginitis in children in institutions, etc.

So long as gonococci persist in secretions or discharges, from a case of the disease, there is danger of exposed persons being infected. Cases of chronic gonorrhea or gleet, may for long periods of time act as carriers of germs of the disease and infect others. Park states that he has had under observation a case where, twenty years after the last exposure to infection, gonococci were still present in great numbers.

Prevention and Control

The same general measures which are used in syphilis, namely, education, social reform and law enforcement should also be applied in the prevention of gonorrhea. These will be outlined in greater detail elsewhere, in the section on venereal disease clinics.

Individual Measures

Early treatment of persons who, a few hours previously, have exposed themselves to infection, is best carried out as described in the section on the prevention of syphilitic infection. Because a patient who has been exposed to gonorrhea may also have been exposed to syphilis, and measures directed against both should be employed. Early recognition of the disease by clinical symptoms supplemented by bacteriological examination of smears is essential.

The fixation test should be carried out with the blood of doubtful cases and especially in cases of gonorrhea in females where infection may have taken place sometime previously. In these cases of gonorrhea in women, the bacteriological examination of smears may be of very little assistance, and the gonococcus fixation reaction in such may be of considerable value. Lailey and Cruikshank have carried out a series of tests in women with most satisfactory results using the technic of Thompson of Rochester Row.

Cases of gonorrhea should be reported at once. Complete isolation of cases of gonorrheal vaginitis is necessary. In all cases of

the disease the greatest care should be taken to disinfect all discharges, and patients should be warned of the great danger of infection of the conjunctiva. Sexual intercourse should be strictly forbidden, and the patients should be given a card with instructions governing conduct during the period of communicability of the disease. Only most careful combined clinical and laboratory examinations will indicate when the patient is probably noninfectious. This should be attempted in every case before treatment is discontinued. Physicians should emphasize the gravity of gonococcus infection. Too often it is assumed by the laymen that syphilis is dangerous, but gonorrhea trivial. It is incumbent upon the medical profession to dispel this misconception.

OPHTHALMIA NEONATORUM

In about 25 per cent of cases of blindness, gonococcus infection is the cause. Cases of blindness in physicians have followed accidental infection of the conjunctivae during the administration of treatment.

To prevent gonorrheal ophthalmia, immediately after a child is born where there is the slightest possibility that the mother is infected the eyelids should be carefully cleansed with a solution of boric acid in sterile water, applied with sterile gauze. The eyelids should then be carefully separated and a couple of drops of a 1 per cent solution of silver nitrate dropped into each eye. It is essential that the solution should come in thorough contact with the eyeball and the conjunctiva of the eyelids. Outfits for this purpose are now distributed very generally by boards of health.

CHANCROID (SOFT CHANCRE)

Chancroid is a local and practically always venereally acquired infection caused by the bacillus of Ducrey. A specific ulcer constitutes the lesion of the disease. These may be single or multiple. They may be prevented according to Park as follows: "The ulcer may be aborted by cauterization if not more than three days old. If this is not done, wash the ulcers with hydrogen peroxide, dry them and apply pure carbolic acid, and then pure nitric acid, wash again with hydrogen peroxide and dust with calomel. Washing

with soap and water immediately after exposure is said will prevent the development of these ulcers."

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CHAPTER XI

TETANUS, ANTHRAX, GAS-GANGRENE, GLANDERS, ERYSIPELAS

There is a miscellaneous group of communicable diseases including *tetanus, anthrax,* and *gas-gangrene,* caused by germs the habitat of which is either the intestinal tract of mammals, or the soil. In each disease, too, the path of infection is through the broken skin. There are two other communicable diseases not related to these, nor to one another, either in their mode of transmission or in the nature of the causative agents, which will also be dealt with in this chapter, in order to complete the discussion of the communicable diseases. These are *glanders* and *erysipelas.*

TETANUS: (LOCKJAW, TRISMUS)

An acute communicable disease, the characteristic symptoms of which are due to the exotoxin of the germ which causes it. Tetanus is one of the three diseases which are true toxemias, the others being diphtheria and botulism.

Incidence

Tetanus is a disease that has been recognized clinically, for many centuries. The most characteristic symptoms are such that recognition is comparatively simple. Owing to the fact that tetanus bacilli are found in the intestinal flora of horse, cows and other herbivora it is, of course, evident that they will be especially prevalent in soil, highly fertilized with such excreta, because they are spore bearing microorganisms and live for long periods of time outside the body. Furthermore climatic conditions in tropical and semitropical countries possibly favor their survival in the soil. This, coupled with the fact that many persons living in such communities walk about with bare feet, provides the opportunity for the germs to enter the body. In addition, cases of puerperal tetanus and tetanus neonatorum are very prevalent in tropical countries like India, China, the Philippines, West Indies, etc. These cases of tetanus arise as a result of infection of women during confinement, and of infection of the newborn child, as a result of tetanus germs

entering the umbilical cord. Such cases of tetanus develop because of the very inadequate arrangements for proper obstetrical service and postnatal care.

In other semitropical or temperate climates, tetanus is nearly always a sequela of wound infection. For that reason, cases have always been unusually prevalent in war-time. The following table from Hinterstoisser shows the comparative frequency of tetanus among the wounded in recent wars, prior to 1914.

	NUMBER WOUNDED	NUMBER OF CASES OF TETANUS.		
Crimean War	12,094 British	19	–	0.15%
American Civil War	217,000	505	–	0.20%
Russo-Turkish War	51,700 Russian	66		0.12%

According to the same authority, there were, on the Western Front, among 27,677 German wounded, 174 cases of tetanus, during two months. This is an incidence of 0.62 per cent. The incidence of tetanus among British wounded during 1914, 1915, and part of 1916 is shown in the following diagram from Adami. This indicates also, the extraordinary value of prophylactic injections of tetanus antitoxin. (Fig. 36.)

Sir David Bruce, Chairman of the British War Office Committee on tetanus, has pointed out that there were 1,450 cases of the disease in wounded men returned to England during 1914-1918, and if tetanus antitoxin had not been used as a prophylactic there would presumably have been some 14,000 cases.

The incidence of tetanus in civil life, in temperate zone communities, is determined by the number of deep puncture, lacerated or contused wounds, or injuries, that have been contaminated with street dust, sweepings of the road, or garden, or field soil, or manure in which tetanus spores may be present.

In the United States cases of tetanus following Fourth of July injuries were for some time very prevalent. For example, in 1903, there were 406 deaths following the receipt of such injuries. Thanks very largely to the propaganda effort of the *Journal of the American Medical Association* in advocating a "Safe and Sane Fourth," and in urging strongly the prophylactic use of tetanus antitoxin, the reduction in cases of tetanus thereafter was as follows:

1904	105 cases	
1905	104 "	
1906	89 "	
1907	73 "	
1908	76 "	
1911	18 "	10 deaths
1912	7 "	6 "
1913	4 "	3 "

In 1907 it was stated editorially in the *Journal of the American Medical Association* that, "A fairly careful scrutiny of the American

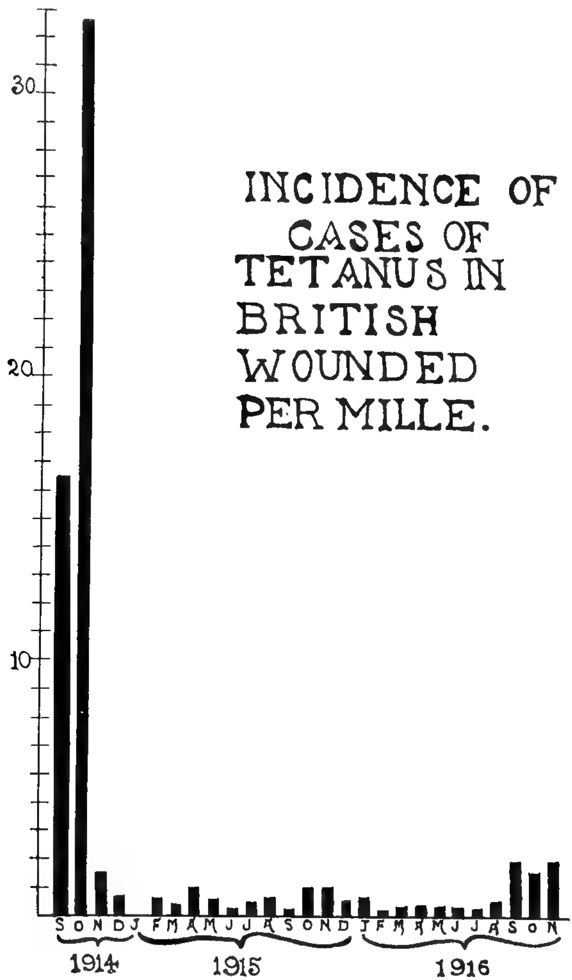

Fig. 36.

literature for the past five years has not brought to light a single report of the development of tetanus in a person who received a timely prophylactic dose of tetanus antitoxin."

While tetanus infection is especially likely to follow deep puncture wounds, it occasionally follows scratches, abrasions, etc., where tetanus bacilli are carried into the wound mixed with other aerobic germs which provide suitable growth conditions for the tetanus organisms. Blank cartridge wounds (when contaminated with dirt and not properly treated) have been frequently followed by tetanus.

Etiology

In 1885 Nicolaier produced tetanus in animals by inoculating them with garden soil. In the animals so infected he found tetanus bacilli. Kitasato in 1889, isolated the germ in pure culture and established its etiological relationship to tetanus.

Modes of Transmission

Tetanus is always a local infection, but is accompanied and characterized by symptoms of a toxemia. The exotoxin elaborated has two chief actions, and is sometimes said to have two elements. One produces muscular spasm by its effect upon the ganglion cells, and is called tetanospasmin; the other acts on red blood cells causing them to undergo lysis, and is designated tetanolysin.

The bacilli are introduced into the body in dirt, usually through the skin as a result of trauma. After their entrance a certain time elapses before symptoms appear. This incubation period varies from six to fourteen days, most frequently it is nine to ten days. During this time the bacilli are elaborating toxin locally. From the site of the wound the toxin passes to the central nervous system. It is probable that the toxin is absorbed by the way of the lymphatics of the peripheral nerves. It has a strong affinity for nerve cells. The toxin is taken by these lymphatics to spinal motor ganglia, or is absorbed by the blood, and distributed to the various muscles, and reaches the central nervous system, probably indirectly, through absorption by the end-plates or motor nerves. The toxin having thus reached the motor spinal ganglia affects the ganglia on the opposite side. They are rendered hypersensitive, and, in consequence, a condition of increased muscle tonus or rigidity develops.

If more toxin is absorbed, the nearest sensory apparatus is affected; this is evident by the increase in the reflexes in the region where the local infection occurred, if this region is irritated. The further production and absorption of toxin affects more motor centers and the neighboring sensory apparatus, and finally the toxemia leads to a spasm of all striated muscles and general reflex tetanus. (Park.) The amount of toxin absorbed determines whether the case is to be one of localized or generalized tetanus. Toxin when conveyed to the central nervous system becomes bound to the nerve cells. Toxin is produced probably very soon after the first twenty-four hours following infection and absorption may begin at once. This is of great significance in prophylaxis.

Any wound into which material containing tetanus spores is introduced may result in a case of tetanus developing. Wounds, however, that are at once opened up and cleansed out thoroughly, are not likely to become a source of danger. The tetanus bacillus is an obligative anaerobe and ordinarily will grow in the presence of oxygen only when it is mixed with aerobes. Therefore, wounds in which the dirt containing spores is carried deep into the tissues are always more likely to give rise to the condition. In puerperal tetanus and tetanus neonatorum, through heavily polluted soil or clothing the germs are introduced at the time of delivery; or are carried into the unhealed umbilical cord of the child shortly after birth. Under proper aseptic conditions, this infection of mother and child does not occur. The chief sources of infection are animal manure itself and soil containing such.

Prevention and Control

The extraordinary difficulties in limiting infection of wounds under certain conditions is indicated by the fact that less than 3 per cent of gunshot wounds among the British, investigated by the War Office Committee on Tetanus, were found to be free from bacteria. Devitalization as a result of trauma, and sepsis due to the entrance of other bacteria undoubtedly favor tetanus infection. In another investigation made by the above Committee, in 30 excised wounds virulent tetanus bacilli were demonstrated only once, while in 70 nonexcised wounds they were found 18 times (25.8 per cent).

Every infected wound should be thoroughly treated immediately.

The skin surrounding the injured area may be painted with a 3 per cent alcoholic solution of iodine. All foreign bodies, etc., should be removed, and wide excision of the devitalized and probably infected tissue undertaken. In the case of puncture wounds, wide and deep incisions should be made to permit of thorough cleansing. All loose tags and shreds of tissue should be swabbed out with a 3 per cent iodine solution. The wound may then be dressed with gauze soaked in the same solution. A prophylactic dose of 1500 units of tetanus antitoxin should be given at the same time. A portion of the body should be chosen as the site of the injection where there is much loose subcutaneous tissue, and the injection made directly under the skin. It is sometimes recommended to inject the antitoxin into the tissues about the wound area. The prophylactic dose of tetanus antitoxin should be repeated if the wound does not heal within seven days. This may be required a third or fourth time also. The practice in the British Army was based on the following instruction: "It is impossible from the appearance of any wound to determine whether it is infected with tetanus bacilli or not, and whereas many cases of tetanus have occurred not only in men with healed wounds but also in those whose wounds were from the beginning apparently clean, it has been decided that all wounded men shall receive at least four subcutaneous injections of antitetanic serum; that is to say, a primary injection at the time of the wound, and second, third and fourth injections at intervals of seven days." (War Office Memorandum on Tetanus.)

In England alone during the War (1914-1918) about 2,000,000 prophylactic doses of tetanus antitoxin were given. In this great number there were only 11 cases that gave a reaction (anaphylactic shock) and all recovered. Local reactions, urticaria, pain in the joints, etc., (the usual symptoms of serum sickness) follow, after about a week, in a large percentage of cases. These cases of serum rash are not serious and are very transient. The value of antitoxin in the prevention of tetanus has been firmly established. As a prophylactic remedy tetanus antitoxin ranks with diphtheria antitoxin, as an absolutely specific method of prevention. It confers a passive immunity of temporary duration and if longer protection is required, repeated doses of the serum are necessary.

The curative treatment of tetanus with antitoxin, once the disease has developed, should always be undertaken if possible. The following extract from the article on tetanus by the author in Nelson's Loose Leaf System of Medicine, indicates specifically a procedure which may be followed.

"Time is the factor of greatest importance in the treatment of tetanus once symptoms are manifest. A delay of even a few hours may mean failure in a case where, had antitoxin been administered immediately, neutralization of the toxin might have been effected before the poison had fixed itself to the central nervous system. The objective in the treatment in every case of tetanus is to neutralize the toxin before it becomes fixed, or before it becomes fixed in such quantities as to certainly produce fatal results. It has already been shown that in military cases, the type of tetanus observed became definitely modified by the use of tetanus antitoxin as a prophylactic. The change in the clinical character of the cases consisted in a lengthening of the incubation period, and an increase in the number of cases of localized tetanus, and finally in a great lowering of the death rate. The mortality rate in 1914-15 was 58.4 per cent and in 1916-17 it was 19 per cent in cases of tetanus treated in Military Hospitals in the united Kingdom.

"The first step in the treatment of a case of tetanus consists in the immediate administration of tetanus antitoxin. This may be given subcutaneously when forty-eight hours is required for complete absorption; intramuscularly, full absorption when it is so given requiring at least twelve hours; intravenously, where general diffusion occurs at once (by this method, most rapid neutralization of circulating toxin is obtained); and finally by intrathecal (or intraspinal) injection. It is not recommended that antitoxin be given subcutaneously in the treatment of the disease, unless the neutralization of all circulating toxin has already been accomplished and there is some definite contraindication to intramuscular injection or to provide a final reservoir of antitoxin from which it may be slowly absorbed. As a result of the experience gained in the treatment of 1,400 cases, the War Office Committee is "of the opinion that in acute general tetanus the best method of treatment lies in the earliest possible administration of a large dose of antitoxic serum by the intrathecal route, repeated on the following day,

combined with the following on succeeding days by subcutaneous and intramuscular injections."

It should be remembered that the introduction of the serum into the subarachnoid space, as a rule, produces turbidity of the cerebrospinal fluid due to polynucleosis. There may be associated with this, transient symptoms of meningeal irritation. This usually need cause no alarm, as it quickly passes off. With strict regard for aseptic precautions, the danger of infection is very slight. The administration of tetanus antitoxin by mouth or by rectum is probably useless and wasteful.

In the chronic, localized forms of tetanus, the antitoxin should be administered by intramuscular or subcutaneous injection; it need not then be given intraspinally, so long as the symptoms remain purely local.

The best results in the treatment of tetanus are obtained where very large doses of antitoxin are given. The object is to "saturate the body with antitoxin and keep it saturated." It is frequently desirable to give as much as 50,000 to 100,000 units during the first few days of treatment. The intraspinal injection of serum should be preceded by the withdrawal of cerebrospinal fluid. Lumbar puncture, as a rule, can best be done under general anesthesia in these cases. The amount of antitoxin injected intraspinally should always be less in quantity, than the amount of cerebrospinal fluid withdrawn. It is usually necessary to withdraw from 20 to 30 c.c. of fluid prior to the injection of antitoxin into the subarachnoid space.

If difficulty is experienced in withdrawing cerebrospinal fluid and only a small amount can be obtained on making a lumbar puncture, the amount of antitoxin injected should not be great and it should be given very slowly. From 5,000 to 15,000 units may be given at the first intraspinal injection, depending upon the amount of cerebrospinal fluid which has been drawn. As a rule 15,000 units is quite an adequate single intraspinal dose. This dose may be supplemented by an intramuscular or subcutaneous injection of 8,000 or more units. Daily repetition of these doses will at first be necessary. When the symptoms become less acute, the intervals between injections may be lengthened.

If serum is given intravenously, preliminary desensitization is desirable. This consists in the subcutaneous injection of 1 c.c. of

antitoxin some hours before the intravenous injection is given. Anaphylactic shock associated with intravenous injection is least likely to occur if the patient is anesthetized, the injection given very slowly, the serum warmed before injection, and, finally, if serum which has been diluted with sterile physiological salt solution is used for this injection.

The following outline of treatment as suggested by the Tetanus Committee may serve as an example of serum treatment, in early acute tetanus in an adult.

DAY	SUBCUTANEOUS	INTRAMUSCULAR	INTRASPINAL (INTRATHECAL)
1st day	....	8,000	16,000
2nd "	....	8,000	16,000
3rd "	....	4,000	......
4th "	....	4,000	......
5th "	2,000 - 4,000	.....	......
7th "	2,000 - 4,000	.....	......
9th "	2,000 4,000	.....	......

This may be supplemented by intravenous injections, and of course, the amounts here given may require to be increased or diminished, depending upon the condition in each individual case.

In purely localized tetanus 3,000 to 6,000 units given every second or third day by intramuscular or subcutaneous injection, may be quite sufficient. At the first sign of generalized tetanus, however, an intrathecal dose of antitoxin should be given.

Symptomatic Treatment

Symptomatic treatment consists in the administration of sedatives. Morphia in doses of ¼ of a grain may be given every four hours. Chloral hydrate, potassium bromide, or paraldehyde, may also be given by mouth or by rectum. Chloroform inhalations are of value in the control of the spasms. The chloroform should be most carefully administered.

There is no satisfactory evidence to show that the use of carbolic acid serves any useful purpose in the treatment of tetanus. Magnesium sulphate has no specific effect upon the disease, cessation of spasm follows its use, but in the opinion of the Tetanus Committee this cessation of spasm "is purchased at the cost of risks which are far from negligible."

Animal experiments have shown that operative treatment is of no value as a curative measure in tetanus. Furthermore, the experience gained during the War suggests that amputation not only is of little value during an acute attack of the disease, but may result in the early death of the patient. No operative interference should ever be undertaken in such cases unless the patient has been thoroughly saturated with antitoxin, preferably, at least twenty-four hours previously.

In cases of tetanus complicated by general septicemia, the possibility of lumbar puncture being a factor in the causation of meningitis, as pointed out by Wegeforth and Latham, should be remembered.

GAS GANGRENE

Gas gangrene is a condition arising from infection of wounds or injuries as a result of the invasion of bacteria belonging to the group of obligative anaerobes, other than tetanus, found in soil and in the intestinal tract of man and animals.

Incidence

The disease is relatively very uncommon, under ordinary conditions, in large centers of population where adequate hospital facilities exist. It was extraordinarily common in war wounds, especially in cases where, as a result of the exigencies of the military situation, early surgical treatment could not be carried out. In unorganized, newly settled communities, such as mining or lumber camps, or other similar settlements where facilities for early surgical treatment have not as yet been established, it may occur. Its relative prevalence may be judged by the fact that in a large general hospital in the City of Toronto in 1920, there was one case only, among several thousand cases of surgical conditions of all kinds. During the War, 97 per cent of wounds were infected; practically all of these were contaminated with dirt containing germs capable of giving rise to gas gangene. However, the condition developed only in those cases in which early and vigorous surgical treatment, by excision, was not undertaken.

Etiology

The germs which cause gas gangrene infection are obligative anaerobic bacilli. There may be one or more species present in any case. The germs live in the intestinal tract of mammals and are also found in great numbers in soil contaminated with excreta of man or manure from animals. Highly fertilized soil, therefore, always contains a great many of these bacteria. The principal species are B. welchii (B. aerogenes capsulatus), Vibrion septique, B. oedematiens, B. sporogenes, etc.

Modes of Transmission

Gas gangrene infection is caused by entrance of the above mentioned species of bacilli through the broken skin, usually as a result of trauma. The germs are carried into the wound by a foreign body, or by neglect of the injury and its subsequent contamination with dirt on clothing, hands, etc. Once the germs find their way through the skin they multiply rapidly. This is rendered possible by the fact that mixed infection (aerobic and anaerobic bacteria carried into the wound at the same time) is the rule. If such wounds, soiled with dirt, are neglected for twelve to eighteen hours or more they quickly show evidence of the disease. Destruction or devitalization of large areas of tissue are especially likely to favor the development of the condition.

Method of Prevention

Readily accessible hospital, or first aid stations, in all places, like industrial plants, etc., where accidents may occur is essential. The early and free excision of soil infected wounds and appropriate local treatment, reduces the likelihood of infection to a minimum. As a result of the work of Bull and of Weinberg and his associates, a specific serum is now available for the treatment of cases of the disease once they develop. Such specific treatment should always be used as an auxiliary measure with proper surgical treatment. A serum of this sort may be combined with tetanus antitoxin.

ANTHRAX

An acute communicable disease, primarily of animals, occurring particularly among sheep and cattle. Cases in human beings develop

only occasionally, the result of an infection conveyed from an animal or its hide or hair.

Incidence

Anthrax is one of the most widespread and serious of all communicable diseases of animals in various parts of the world. It is known also as malignant pustule, or wool-sorter's disease when it occurs sporadically in man. While cattle and sheep are most often the victims of anthrax, nearly all warm-blooded species of animals except swine, dogs and birds, are susceptible to anthrax infection. It is of interest to recall that this was the first disease in which it was proved that the cause was a germ. Davaine in 1863 showed that a large coarse bacillus was present in the blood of animals dying of anthrax. This was confirmed in 1877 by Pasteur and Koch. From an economic standpoint the disease is of very great importance in many countries. It is most prevalent in Europe, South America and Asia. In Europe, France, Germany and Russia have been the countries where the most serious epidemics of anthrax have occurred. In the Argentine, China, India and Persia also, anthrax is very prevalent. Among sheep and cattle the disease is more prevalent in hot, summer months.

In man the disease occurs in sporadic form and is always secondary to infection in animals.

Etiology

The cause of the disease is the Bacillus anthracis (Davaine 1863, Pasteur and Koch 1877). It is a spore-bearing bacillus and is extremely resistant to all unfavorable influences. It will survive in soil for years, and withstands in the spore state, the deleterious action of heat, drying, and germicidal agents, in a remarkable fashion.

Mode of Transmission

Usually the germ enters the body in human cases, through the broken skin. Less commonly it pierces the wall of the intestines or is inhaled and enters through the respiratory path. In animals, infection is believed to occur most commonly as a result of the germ

entering the body through the broken skin as a result of some injury and subsequent contamination of the wound area with soil containing anthrax spores. Occasionally, however, in cases of anthrax the site of entrance of the germ cannot be ascertained.

Human cases have been most common among those engaged in handling hides or wool, etc., obtained from animals that have died of anthrax. In certain countries it thus assumes importance as an occupational disease. Of course, it arises occasionally from contact with an animal suffering from the disease. The hide and hair of such animals, however, after death, is the most likely source of human infection because the animal excretes them in the feces. Shaving brushes, hides and wool of dead animals, and feces of living animals are the main sources of human infection.

Accidental infection of slight wounds, such as scratches, is the usual origin of human cases of localized, external infection, so-called malignant pustule. Generalized infection may result from ingestion in consequence of eating infected meat, or pulmonary invasion of the germ by inhalation may occur. In such cases a generalized septicemia results and death ensues. The incubation period of the disease is usually seven days, though occasionally it may be shorter.

Human cases and living infected animals are a source of danger to others as long as they harbor anthrax bacilli. The infected hides of animals are a menace for long periods, unless they are disinfected. Land on which anthrax cattle have grazed is very often a source of infection. Tanneries receiving infected hides from countries where anthrax is prevalent, may cause soil pollution, unless very stringent regulations requiring the disinfection of such hides before shipment, are required.

Prevention and Control

Human cases of anthrax are best treated in a hospital. If this is impracticable, the case must at once be reported and careful concurrent disinfection of all discharges, etc., carried out. Infected persons are better isolated in order to avoid the possibility of transfer of infection. For human cases there is no specific method of prevention or treatment. In intestinal anthrax, feces must be disinfected as must the sputum in pulmonary cases of the disease.

The early recognition of localized anthrax, the pustule or carbuncle is very important. Clinical and bacteriological evidence should be obtained in every suspected case. Persons engaged in handling hides, or wool, or presenting symptoms or pustule arising as a result of shaving, should have a bacteriological examination made of the discharge from the lesion.

Stringent regulations relating to the measures to be adopted when the disease is found in cattle in any community, are carried out by government departments of agriculture. If it is found that a case has arisen from an infected animal, the proper authority representing such a department should be notified. Where anthrax is known to exist, hides and wool should be disinfected. Shaving brushes from doubtful sources should never be offered for sale. Tannery employees and others if developing a pustule should receive early treatment. By the development of divisions of industrial hygiene and the enactment of workmen's compensation legislation, many states and provinces have made provision for such infected employees. Measures to prevent infection have also been instituted. The carcass of an infected animal should not be used for food.

GLANDERS

Glanders is an acute communicable disease of animals, occasionally conveyed to human beings by accident.

Incidence

Among animals, especially horses, this disease is quite prevalent. Other animals are susceptible to infection, among these asses, dogs, cats, ferrets and guinea pigs are most likely to develop the disease, if exposed to infection. Sheep, swine, and goats are less susceptible, and cattle are immune.

Man is quite susceptible to infection. Cases are uncommon, however, and usually sporadic in occurrence. Most frequently they have resulted from the transfer of infection from animals, although a number have also been the result of accidental, laboratory infection.

Etiology

Glanders is caused by B. mallei which was first isolated in pure culture and carefully investigated by Löffler and Schutz in 1882.

Modes of Transmission

In both animals and man there are two clinical varieties of glanders, acute and chronic. The disease is transferred to human beings, as a rule, in nasal or other discharges of "glandered" horses, by direct contact, and the germs enter the body through the broken skin or through the mucous surface. In accidental laboratory infection, the same path of entrance is followed. One infected individual may transmit glanders to another, in nasal discharges, etc.

The disease in horses when the lesion develops in the mucous membrane of the nasal cavity, is called glanders, when localized beneath the skin it is known as farcy. Human cases arise most frequently from direct contact with horses suffering from glanders or farcy, or indirectly through contact with fomites wet with such secretions. The incubation period in human cases is not known. Glanders in man is a very fatal disease, the mortality frequently being as high as 60 per cent.

Prevention and Control

Early recognition of cases in both man and animals by laboratory tests as well as by clinical symptoms is very important. The bacteriological investigation consists in the examination of direct smears, and preparation of cultures of suspected material, and the inoculation of male guinea pigs. In these the so-called Straus reaction (swelling of the testicles) occurs in guinea pigs injected with material containing the bacillus mallei. Fixation and agglutination are specific serum tests which may also be applied.

The case must be reported, and the patient should at once be isolated. The discharges, excretions, etc., should be disinfected concurrently. There is no specific method of prevention or treatment.

The control of the disease in animals is under the direction of veterinarians in departments of agriculture. The occurrence of a

human case should be brought to the attention of the proper person charged with the administration of regulations governing the control of animal diseases.

ERYSIPELAS

An acute communicable disease of man, erysipelas, known from earliest times, has since the introduction of aseptic and antiseptic methods ceased to be the serious menace it formerly was.

Incidence

Erysipelas in the past appeared in endemic form, and epidemics occasionally spread very widely. Hospital and other institutional epidemics were of frequent occurrence about the beginning of the nineteenth century, at which time, a great variety of opinions were held as to the reason for such epidemic appearances of the disease. Epidemics and indeed, endemic prevalence, are now unknown. It occurs at present in sporadic form only.

Etiology

The cause of the disease is a type of streptococcus, first isolated in pure culture by Fehleisen in 1883. This was first known as the Streptococcus erysipelatus, but also known as Streptococcus pyogenes or streptococcus, beta type, of Smith and Brown. This is a type of streptococcus which produces hemolysis of red blood cells.

Mode of Transmission

The germ that causes the disease is found in human beings, and they are the sole reservoirs of infection. The germ is conveyed by direct contact or through an intermediary; or indirectly by fomites from an individual suffering with erysipelas, to a susceptible contact. The path of infection is through the broken skin or mucous membrane. Infection of wounds, slight or severe, in persons who have little or no resistance, results in the development of the disease. One attack does not confer immunity; on the contrary, relapses, or second attacks are very common. The incubation period may be from three to ten days.

Prevention and Control

With the recognition first, that this disease was due to a germ, and then appreciation of the fact that it was the result of contact infection, has led to the introduction of simple procedures, as a result of which, erysipelas is now very much less prevalent than formerly.

In many states and provinces the disease is still required to be reported; where this is required it should, of course, be notified. The most important measure is the isolation of the case, and the adoption of stringent precautions to prevent the further spread of the disease by:

(a) Careful aseptic nursing (including the use of a gown, and mask if necessary), separate thermometer, etc., and by washing the hands and face after contact with the patient; changing the gown before coming in contact with any one else.

(b) Concurrent disinfection of all secretions and discharges.

(c) Disinfection or sterilization of all personal and bed linen and all objects, dishes, etc., used by the patient.

(d) Terminal disinfection, cleansing, etc., of the room, together with its contents, in which the patient was confined.

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CHAPTER XII

GENERAL METHODS FOR THE CONTROL OF COMMUNICABLE DISEASES

The physician when called to see a patient who is, or may be, suffering from a communicable disease has a very definite responsibility to his patient and to the community. He must at once take all necessary precautions to prevent the further spread of the disease. His first duty is to report any such cases. The following are those generally included in the category of notifiable diseases:

1. Smallpox
2. Leprosy
3. Scarlet fever
4. Diphtheria
5. Bubonic plague
6. Asiatic cholera
7. Measles
8. Anterior poliomyelitis
9. Cerebrospinal meningitis
10. Pneumonia
11. Influenza
12. Typhoid fever
13. Paratyphoid fever
14. Dysentery
15. Chickenpox
16. Whooping cough
17. Mumps
18. Glanders
19. Anthrax
20. Tuberculosis
21. Rabies
22. Erysipelas

The list varies slightly in different places, and the physician should always be careful to inform himself as to the regulations in his own state or province.

In the above list patients suffering from any one of the diseases numbered 1 to 9, are usually required to be *reported*, and the *house is placarded*, the *contacts quarantined*, and *terminal disinfection carried out.*

Cases of those diseases numbered from 10 to 14 are as a rule, *required to be isolated*, and *terminal disinfection carried out;* for the others, 15 to 22, *notification only* may be necessary.

Regulations governing the cleansing, renovating and disinfection of premises during and after the occurrence of a case of communicable disease are laid down by the proper public health authority, but no standard regulations have been adopted. The execution of these regulations is as a rule the duty of the local board of health. However, the physician should not only see that appropriate meas-

ures are applied, but should be in a position intelligently to direct such efforts, if necessary.

The value of isolation, and medical and nursing asepsis has already been emphasized. Grancher in 1888, first demonstrated in his service at the Hôpital des Enfants Malades, in Paris, that the application of the principles of asepsis, in the medical and nursing care of those suffering from transmissible diseases, practically eliminated cross-infections; and he proved also that separate wards for different kinds of communicable diseases were unnecessary. It was shown that cases of diphtheria, scarlet fever, etc., could all be treated in the same ward, if proper precautions were taken.

Since a separate cubicle for each individual patient may not always be feasible, it is very essential that the principles of aseptic medical and nursing care be understood and applied. It consists simply in making the transfer of secretions, excretions, etc., from a case of any communicable diseases to others impossible. A screen about the bed may be desirable, but neither cubicles nor screens are really essential if proper care is exercised. Every patient has beside his bed everything he requires, utensils, thermometer, towels, etc. Physicians, nurses and others who come in contact with the patient, wear gowns and masks. The hands are always washed after contact with any patient before going on to the next. The gown worn while in attendance on one type of case is changed before coming into contact with those suffering from another variety of communicable disease. An absolute physical barrier is thus established, which renders the transmission of disease-producing microorganisms from one individual to another, impossible.

It is highly desirable for physicians and nurses carefully to explain these principles to all those who have to come in contact with patients suffering from transmissible diseases, and, invariably, in the execution of their own duties, scrupulously to carry out in practice, what is here outlined in principle.

A very excellent procedure is for the physician at the first visit to leave formal written instructions as to precisely what care and precautions should be adopted. If such written instructions are issued in this way, the objections to isolation, etc., are met more than half way, before they are raised. Thus the necessary measures

for the prevention of further spread of the disease, are made an integral part of the treatment of the individual case.

For example, a child is visited and found to be suffering from measles or bronchopneumonia. The physician leaves written instructions in a general way as follows:

1. *Isolate*: Explain how this is to be done.
2. *Details as to aseptic nursing*, developing the idea of an invisible barrier.
3. *Diet.*
4. *Directions as to medical or other treatment.*

He should also inform those caring for the patient, that the case will be reported, and outline what necessary public health measures will be carried out by the representatives of the local board of health. Certain additional practical points in connection with disinfection, sterilization and fumigation will next be outlined, because their execution may devolve upon the physician, or he may require to issue explicit directions as to how they should be carried out. Various methods of ascertaining the value of chemical disinfectants, and of standardizing them, have been elaborated and are of considerable interest from an economic as well as scientific standpoint.

There are three well-known methods for the standardization of disinfectants; these are: the Rideal-Walker, the Lancet, and the Hygienic Laboratory (U. S. P. H. S.) methods. The object in each of these is to ascertain the germicidal power of the disinfectant in terms of the bacteria-destroying capacity of carbolic acid (phenol) by comparing any disinfectant with different strength solutions of carbolic acid (phenol), under certain standard conditions.

The standardization of disinfectants by the method elaborated by Anderson and McClintic, is known as the "Hygienic Laboratory phenol coefficient." This permits of the determination of the value of any germicidal agent, either in the presence or absence of organic matter, and by use of the simple formula the comparative cost per unit of efficiency can be ascertained.

McClintic and Worth Hale have investigated also the phenol coefficient and relative toxicity of various commercial disinfectants, and their reports should be consulted by those who may have to use large quantities of chemical disinfectants.

Many of the ordinary commercial disinfecting agents have very

little germicidal power and their unit cost is out of all proportion of their value. Chemical disinfectants should be purchased on the basis of their guaranteed phenol coefficient, tested by the Hygienic Laboratory method.

The memorandum on disinfection of the Provincial Board of Health, of Ontario, has been freely drawn upon in the compilation of the following, and the author's thanks are due to Dr. McCullough, Chief Officer of Health, for kind permission to use the data therein contained.

Extract from memorandum on cleansing, disinfection, etc., of the Provincial Board of Health of Ontario:

Concurrent disinfection is the destruction of microorganisms or their products which may cause disease. *Terminal disinfection* is that carried out when the patient ill of a communicable disease is recovered, removed or dead.

The principal objects that need disinfection are the discharges from the body, towels, bedding, toys, handkerchiefs and fabrics, food, dishes and table-ware that has been mouthed; also the hands of the physician, nurse, mother and others who come in contact with the infectious material.

Fomites, such as letters, books, woolen garments, umbrellas, curtains and furniture are not likely to carry the disease, but it is a wise precaution to carry out disinfection, not necessarily fumigation, after every case of a communicable disease.

The greater the care exercised during the progress of the disease, the less there will be to accomplish by terminal disinfection.

Fumigation consists in liberating fumes or gases, with the object of destroying bacteria, vermin, insects, rats or mice and other small animals which may be concerned in the transmission of infection. The chief chemicals used in fumigation are formaldehyde and sulphur dioxide. Formaldehyde is a good germicide but it has little effect on harmful insects. Fumigation is not a substitute for disinfection, as gases act only on the surface of objects, and do not penetrate fabrics, books or masses of sputum.

Fumigation and terminal disinfection are precautions against the transmission of communicable disease, necessary only in cases where cleanliness and disinfection have been neglected during the progress of the disease.

Fumigation should not be carried out unless the medical officer of health deems it advisable. In such cases, it should be thoroughly done under the supervision of the local board of health. It is essentially of benefit to the community and its expense is borne by the municipality as a rule.

Sterilization not only destroys all the pathogenic germs, but also destroys spore-bearing species of microorganisms such as anthrax, tetanus, malignant edema and the gas bacillus group of germs.

Antiseptics are substances which retard decomposition. They do not necessarily destroy the germs which produce putrefaction and fermentation, but they delay their action. For example, a weak solution of bichloride of mercury (1 in 300,000) will sometimes prevent the development of anthrax spores, while it requires a 1 in 1,000 solution to destroy them.

Disinfectants or germicides are agents which destroy all germs, or their toxic products.

Deodorants are substances which destroy or neutralize unpleasant odors; charcoal, for example, will absorb odors, and formalin will both disinfect and deodorize. Bichloride of mercury will destroy germs but it has no deodorant action.

Nature's disinfecting agencies are dilution, sunlight, drying and the destructive action of bacteria upon one another. The combination of drying and sunlight is quite as good as much of the fumigation as it is ordinarily carried out.

Very few species of disease-producing microorganisms grow and multiply outside the body. Fortunately for the human race, these germs soon die when wafted into the air, deposited on surfaces, conveyed in water, or placed in the soil. It requires a certain number of germs to produce infection. For example, it is said that ten tubercle bacilli are necessary to produce tuberculosis in a guinea pig. Dilution and reduction of the number of germs, cleanliness, drying and sunlight afford great protection against communicable diseases. Close personal association with persons ill of these diseases is most likely to result in the transmission of infection.

Dry dusting and sweeping stir up dust and possibly infectious material which settles down again on the same, or other surfaces. Cleansing with soap and water serves to remove disease germs, and also destroys the organic matter in which bacteria may find favor-

able conditions for growth. In dealing with communicable diseases two important points should be remembered:

(a) Always wash the hands with soap and water after using the toilet or handling objects which many persons may have touched.

(b) Keep the fingers away from the mouth and nose when they may be soiled with pathogenic germs.

Surfaces such as woodwork, seats, floors, desks, door knobs, and handles in schools, factories, shops, public conveyances and places of assembly should when possible, be frequently scrubbed with hot soap suds and strong solution of washing-soda. The same procedure applies to the seats of water closets, privies, wash basins and other objects used in common.

In the process of *putrefaction and fermentation* which are carried on by germs, there is often a vigorous struggle for existence. Saprophytic germs, causing putrefaction, are often more resistant than those causing diseases. As a result saprophytic bacteria often destroy pathogenic species.

It is more important to prevent infection than to attempt to destroy it after it has been disseminated. The place to apply disinfection is at the seat of its origin. Man is the source of most infection, hence the most effective place to apply disinfectants is at the bedside. The secretions and excretions, especially those from the mouth, nose, bowels and bladder, as well as the discharges from eruptions and wounds, need the most scrupulous attention. If the discharges in cases of cholera, dysentery, typhoid fever or plague are disinfected at the bedside, there is little need of disinfecting the sickroom. If the discharges receive little or no attention, disinfection of the room and clothing is essential.

The ideal disinfectant must possess high germicidal power. It must not be rendered ineffective in the presence of organic matter; it must not readily deteriorate; it should be soluble and readily miscible with water; it must be harmless to man and the higher animals; it should have the power of penetration, but should not corrode metals, bleach, rot or stain fabrics, and it must be reasonable in price.

Direct sunlight is a valuable bactericidal agent. The direct rays kill bacteria in both the spore and vegetative stage. Rooms and

objects may be sunned and aired with advantage after disinfection. The value of sunlight in destroying germs of disease varies with its brightness and with conditions of moisture, temperature and transparency of the media. Plague bacilli and cholera vibrio are more easily destroyed than tubercle bacilli. The spores of anthrax require about 30 hours' exposure to the sun, while the vegetative forms are killed in one or two hours.

Garbage and refuse of no value, sputum, infected dressings and discharges of wounds should be burned. Except under very unusual conditions it is rarely necessary to destroy books, clothing or other articles which may be readily disinfected by other means.

A temperature of 150° C. continued for one hour will kill all forms of life, even the most resistant spores. Glassware in laboratories is sterilized in this manner. This form of disinfection is ordinarily not as useful as moist heat, because it lacks the power of penetration and destroys fabrics. Many materials will withstand a temperature of 110° C., but will scorch, if a higher temperature is applied. In the absence of a proper sterilizer, the ordinary household oven will give satisfactory results. The oven should be heated sufficiently to brown cotton, and the objects to be disinfected should be exposed to its heat for one hour.

Boiling is a valuable method of disinfection. The water should be brought to a temperature of 100° C. (212° F.) and held for one hour. The germs of most diseases can be destroyed at a much lower heat than the boiling temperature of water. For example, exposure to a temperature of 60° C. (140° F.) for 30 minutes, will destroy the microorganisms of cholera, typhoid, dysentery, plague, tuberculosis, pneumonia, erysipelas and practically all nonspore-bearing bacteria. But even boiling temperature will not suffice to kill the spores of anthrax and tetanus.

Boiling is a suitable method for the disinfection of bedding, body linen, towels and fabrics of many kinds, also kitchen articles and tableware, bed-pans, cuspidors, urinals and a great variety of objects.

Floors, walls, beds, metal work, etc., may be disinfected by washing with boiling water. The addition of bichloride of mercury, carbolic acid, cresol, lye, or borax, or a strong alkaline soap, increases the effectiveness of the procedure. In using boiling water for the

disinfection of cutting instruments, the addition of 1 per cent carbonate of soda, will prevent rusting and injury to the cutting edge.

Steam is one of the best disinfecting and sterilizing agents. Bacteria are destroyed at once, and nearly all spores, in a few minutes. Streaming steam for half an hour is sufficient. Steam under pressure of 15 pounds to a square inch has a temperature of about 120° C. and will effect sterilization in twenty minutes.

Steam may be used for the disinfection of bedding, clothing, and fabrics of all kinds, but it will shrink woolens, and injure silks, leather, fur, skins, rubber goods, oilcloth, etc. An autoclave is the best apparatus for the purpose, but the use of a cheap boiler and an air tight chamber will give good results.

The gas most suitable for fumigation is formaldehyde. It is not poisonous, does not injure fabrics, colors, metals, pictures or other objects of value.

Sulphur dioxide is also used, but it destroys fabrics, colors and metals. It is very valuable for the fumigation of the holds of ships, cellars, sewers, stables and other rough structures infested with vermin. Chlorine gas and hydrocyanic acid gas are too toxic to be used with safety.

In fumigation, haphazard work will not give results. It is of little value to burn a few formalin candles in a room. Fumigation so carried out gives a false sense of security. At best, fumigation with any gas will disinfect the surface of objects only. Gases lack the power of penetration.

Preparation of the Room

(1) All cracks and crevices must be closed by plugging, or plastering paper over them. (2) Registers, flues, fireplaces and ventilators must be stopped up. (3) Beds, bureaus, and cupboards and other furniture should be moved away from the walls. Closets, boxes and drawers should be opened so that the gas may gain ready access to all surfaces. Gases do not penetrate clothing, etc. (4) An excess of gas should be used, for no matter how much care is exercised, part of it escapes. (5) The room should be heated to 60° F. and plenty of moisture secured by boiling water in a large open receptacle in the room.

Disinfection with Formaldehyde Gas

Disinfection with formaldehyde gas is best accomplished by the use of potassium permanganate and formalin. For each 1,000 feet of space, use 16 ounces of formalin to 7 ounces of potassium permanganate. The permanganate is first placed in a galvanized iron vessel (see Figs. 37-A and B) large enough to prevent splashing on the floor, which it might set on fire. Everything being ready, the formaldehyde is added to the permanganate. Very active oxidation takes place with the formation of formic acid and heat. The heat liberates the formaldehyde gas.

The operator should leave the room at once; the margins of the door and keyhole should be plugged with cotton.

The room is left sealed up for at least six hours. The doors and windows may then be opened so as to thoroughly air the room.

Sulphur dioxide is not a very efficient germicide, but is valuable in certain of the insect-borne diseases. Its action is upon the surface and it is only effective in an atmosphere containing 4 per cent sulphur dioxide in the presence of moisture. Even under such conditions spores are not killed.

An iron pot should be placed in a tub containing water. For every 1,000 cubic feet of space 5 pounds of sulphur are placed in the pot. Alcohol is poured liberally over the sulphur, and, the room being prepared as in the formaldehyde method, the alcohol is lighted and the room sealed up. The room should be kept closed for about 24 hours.

Preparation of Solution of Germicides or Chemical Disinfectants

To prepare 5 per cent carbolic acid, add 1 pint, or a pound of either the crude or purified liquid carbolic acid to 2½ gallons of hot water, and stir frequently until no red or colorless droplets remain in the bottom of the mixture.

To prepare bichloride of mercury solution (1-500), dissolve 1 ounce of bichloride of mercury in 4 gallons of hot water. Bichloride of mercury solutions should be made in glass, enameled or earthenware vessels, as they corrode metals.

To prepare 1-1,000 bichloride of mercury solution, dilute one part

Fig. 37A.—Formaldehyde-permanganate Disinfector—closed.

Fig. 37B. Formaldehyde-permanganate Disinfector—open.

of 1-500 bichloride of mercury solution with an equal quantity of water.

Chloride of lime solution (10 per cent). Prepare by adding ½ pound of fresh chloride of lime to 1 gallon of water and mixing thoroughly. This should be prepared as needed. Owing to the importance of using freshly prepared solutions and the favorable effect of the heat produced by shaking upon the efficacy of the disinfection, the following method is recommended. Add unslaked lime directly to the infected material suspended in water in the proportion of one part to eight parts of the material.

When a solution is required the lime should be slaked by mixing one part with four of water, and adding one part of this solution on one part of the material to be disinfected. Such a solution must be used promptly; air slaked lime should not be used.

Liquor Cresolis Compositus is prepared as follows: Mix 1 pound of green soap with 17 ounces of cresol and sufficient water to make 34 ounces of solution. The preparation should be made in a wooden bucket or an earthenware jar. This is valuable as a cleansing and disinfecting agent.

Carbolic acid and bichloride of mercury are corrosive poisons and great care should be taken to see that disinfectant solutions containing them are kept out of the reach of children.

Proper disinfection of sputum and of discharges from the mouth, throat and nose, and from the eyes and ears is very important. The communicable diseases in which these discharges should be regarded as of special significance, as the conveyors of infective agents, are *diphtheria, pneumonia, influenza, mumps, chickenpox, whooping cough, tuberculosis, epidemic cerebrospinal meningitis, poliomyelitis, septic sore throat, scarlet fever* and *smallpox.*

Sputum and other discharges from the mucous membranes are not easily disinfected because the disease-producing organisms are apt to be enveloped in mucus, which disinfectants do not readily penetrate. A 5 per cent carbolic acid solution, is most effective for this purpose. Bichloride of mercury solution is less suitable because in its presence, a layer of albuminate of mercury is formed about the microorganisms, thus preventing access to them.

Sputum, when in considerable quantity, should be received, if

practicable, in paper cups which, with their contents, may be burned. If this is not feasible it may be received in ordinary cups containing 5 per cent carbolic acid solution. When not in large quantities, sputum and other infective discharges from the mouth, throat and nose, and discharges from the eyes and ears should be received on cheap cloth or soft paper and promptly burned. If handkerchiefs are used to receive infective discharges they should be immersed in carbolic acid solution before the discharges dry. After immersion for one hour in an abundant volume of the solution, handkerchiefs or other contaminated fabrics may be laundered.

The Disinfection of Discharges from the Intestinal and Urinary Tract

The communicable diseases in which these discharges are especially significant are typhoid fever, paratyphoid fever, dysentery, etc. In cholera, vomited material may also be infective.

In these diseases the discharges from the bowels, and in typhoid and paratyphoid fever the urine should be received in bed-pans, or other vessels, containing a small amount of chloride of lime solution (½ pound to a gallon of water). A quantity of chloride of lime solution, equal to twice the volume of the discharge, should at once be added, and fecal lumps broken up and thoroughly mixed. The receptacle with its contents, covered to exclude flies, should stand for at least an hour before being emptied into a water-closet, privy or trench. The trench should be 1 foot wide, 3 feet deep, 4 feet long covered with a plank to exclude flies or snow.

After emptying the pans or other vessels which have received such discharges, they should at once be immersed in a disinfecting solution, and the hands of the attendant should then be carefully cleansed or disinfected. Neither the disinfection of the discharge nor the cleansing of the hands must be delayed.

Disinfection of discharges from the genito-urinary tract: If copious, these should be collected on dressings, or sterile absorbent cotton and burned.

Disinfection of discharges from open wounds and from ulcerated surfaces of the skin: These discharges should also be collected on dressings of sterile, absorbent gauze or cotton and burned.

Disinfection of clothing, bed linen, towels, napkins and similar articles which have been contaminated with infective discharges: Such articles should be soaked in carbolic acid solution (2½ per cent) for one hour or longer. Then, after wringing out, they should be boiled for from 10 to 20 minutes, in a soapsud solution, and laundered as usual.

Outer garments of woolen stuffs, mattresses, pillows and similar articles which would entail considerable loss if destroyed should be disinfected by exposure to formaldehyde gas, in a closed room, or in special receptacles or chambers designed for this purpose, or, they may be sterilized by steam, when such facilities are available.

Disinfection of the person: The disinfection of the skin. Simple but thorough cleansing with soap and water is the most important feature in skin disinfection and must suffice for much of the general routine in the care of the patient. But any part of the surface of the body of the patient, or of the attendants, which has been contaminated with infective discharges should at once be washed with carbolic acid solution (2½ per cent), or with 1 to 1,000 sublimate solution, and then washed with soap and water. Alcohol (75 per cent) is also a most serviceable disinfectant for the skin, and will remove the sensation of numbness induced by a carbolic acid solution.

A basin of carbolic acid solution (2½ per cent), or of sublimate solution 1 to 1,000, as well as soap and water, should always be accessible preferably in the room in which a case of communicable diseases is isolated, so that nurses and attendants may quickly rinse, disinfect, and wash their hands after attending the patient.

By the use of rubber gloves much of the discomfort from frequent cleansing and soaking of the hands in disinfectants may be avoided. Rubber gloves are readily disinfected in a 5 per cent carbolic acid solution, or in a 1-500 bichloride of mercury solution; or they may be sterilized by five minutes' boiling. After disinfection or sterilization they should be dried and kept well-powdered.

For hypodermic injection, the site of puncture, after cleansing with soap, may be disinfected with alcohol and ether, or by the application of tincture of iodine.

The disinfection of mucous membranes: Owing to the delicacy of such surfaces and the inconvenience and risk involved in their

injury, it is impracticable to bring disinfectant solutions into sufficiently close contact with microorganisms which they may harbor, and to secure the necessary time of exposure to the solutions, to obtain even approximate disinfection. Here, therefore, as in the case of the skin, it is intelligent cleansing, rather than actual disinfection, which must be relied upon.

Though antiseptics may be used for cleansing purposes, in the mouth, for example, the period of contact between them and the germs is at best too short for the development of even their inhibitory effects.

For the cleansing of the mouth, an alcohol wash or gargle is one of the most serviceable of the antiseptic solutions. A useful formula for such a purpose, alkaline or acid as may be desired, is as follows:

ALKALINE SOLUTION

Sodium bicarbonate	0.5 parts
Glycerine	10 "
Alcohol	30 "
Water	60 "

ACID SOLUTION

Vinegar	10 parts
Glycerine	10 "
Water	50 "
Alcohol	30 "

Thermometers, when in frequent use in the sick room, should be kept in a 2½ per cent carbolic acid solution.

Disinfection of foods: Remnants of food from the sick room should be burned; or, if more convenient, soaked for an hour in a 5 per cent carbolic acid solution or in milk of lime before being discarded.

Disinfection of eating utensils: Eating utensils such as knives, forks, spoons, dishes, etc., used by a patient suffering from a communicable disease should not be used by others, or after use should either be boiled for ten minutes in soapsuds, or first washed in a 5 per cent carbolic acid solution, then in hot soapsuds and rinsed in water.

Disinfection of the person at the end of the isolation period: If all necessary precautions have been carried out during the isolation period, additional measures of disinfection are unnecessary on

release, except in cases of scarlet fever, smallpox, and chickenpox. After these diseases the patient and attendants should wash the entire body and hair with soap and water; brush the teeth, rinse the mouth and gargle the throat with an antiseptic solution (see above). There should also be a complete change of underclothing.

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CHAPTER XIII

WATER

BY H. M. LANCASTER, B.A.Sc.

Water constitutes about 70 per cent of the total weight of the human body and is the medium in which Nature carries on the physical and chemical changes upon which life itself depends. It is, therefore, indispensable for the maintenance of health as well as of cleanliness. The amount of water required for household use is estimated at twenty-five U. S. gallons per person per day. Water has also many uses in the industries and is essential for fire protection. The average consumption of water in cities on this continent is about one hundred gallons per person per day although in some places twice that amount is used. Metering is the only satisfactory means of controlling waste. Dual systems, providing one for industrial and fire purposes, and one for drinking purposes, are not usually successful, especially where the former is contaminated with objectionable or dangerous impurities. It has been generally recognized that every community should be supplied with water of satisfactory quality.

Chemically pure water is rarely, if ever, met with in Nature. The nearest approach to it outside of laboratories is the water which falls during the middle of a shower of rain. Even such water very readily takes up material from its environment. Although it is not possible to provide the household or the manufacturing plant with water which is pure in the chemical sense, there are certain principles established for estimating the danger from disease and the economic loss incurred by using unsatisfactory water. Before pronouncing as to the quality of water to be used for drinking purposes, general household and industrial use, it is desirable to have information supplied by the following:

1. *A physical examination.* (Temperature, color, turbidity, taste, and odor.)
2. *A biological examination.*
    (a) Microscopical examination of sediments.
    (b) Bacteriological examination.
3. *Chemical analysis.*
4. *A sanitary survey or inspection of the source.*
5. *Epidemiological evidence,* that is, whether or not the water is known to have caused disease.

The manufacturer usually requires a water which is free from excessive hardness and iron. The ordinary consumer is concerned chiefly with the qualities of water which affect its attractiveness. People desire a water which is clear, cool, and colorless and without noticeable taste or odor. Unfortunately a water may satisfy these requirements and still be dangerous to health.

The chief water-borne diseases are typhoid fever and diarrhea; dysentery and cholera may also be transmitted by water. These communicable diseases are caused by bacteria, the organisms present in the discharges of those who have or have had the disease finding entrance into water supplies polluted by such discharges. Goiter is also caused by some waters, but the causative agent in such cases is not definitely known.[1]

From the standpoint of public health the dissemination of disease-producing bacteria is the most important feature of water supply problems, although health may be influenced by the fact that if a water is not attractive people do not drink sufficient of it. It has been shown that when the water supply of a municipality has been improved by drawing from another source, or by filtration, not only is there a decrease in the number of cases of typhoid and diarrhea, but there is also a decrease noted in other diseases, especially in children.[1]

SAMPLING A WATER SUPPLY

Sampling a water supply is not a difficult task but it is important that attention be paid to certain essential details. If the temperature of a water is to be observed, it must be determined at the time of sampling. Color, turbidity, taste and cdor can also be determined by comparatively simple tests carried out in the field. But these physical properties are dealt with more completely and extensively in the laboratory and are usually included in the chemical report. The biological examination may be carried out in the field but is essentially a laboratory task.

The early history of water analysis shows that many essential principles were unknown for many years after the work was started. The chemists were the first in the field and undertook to pronounce definitely as to the quality of waters, basing judgment upon the

chemical analysis of samples collected by others who used all sorts of containers. In many cases the analyst had no information regarding the source of supply. For these reasons water analysis was at one time in danger of falling into disrepute. When bacteriology became a science, it was thought that all these troubles would be removed and that the bacteriologist would be able to tell whether or not a water contained pathogenic microorganisms. But it has been found that although it is possible to detect cholera vibrios in colonies on direct culture plates, still the isolation of typhoid bacilli from water is not practicable in routine work. It is necessary to use the colon bacillus as an index of fecal contamination. Moreover, the bacteriological examination deals only with a small portion of water collected at one time, and shows very little about the past history of a water if it does not show direct evidence of contamination with fecal matter. The literature contains records of cases where the chemist has failed and the bacteriologist has been successful, and vice versa. It is now recognized that both can render service, but that they are not independent of the sanitary inspection of the source from which samples are taken and that if a water is known to have caused disease, as judged from the character of an outbreak, the epidemiological evidence still carries weight, even if the chemist and bacteriologist both fail in demonstrating from a few samples that the water is dangerous. It is always to be remembered that contamination may be intermittent and that the water of a large body of water such as a lake is not truly represented by the contents of a single bottle.

It is in most cases impossible for the chemist or the bacteriologist to leave the laboratory and collect samples, although that would be the ideal arrangement. The work of sampling is generally placed in the hands of others. This is satisfactory provided certain precautions are observed. It is desirable that the outstanding features of the sanitary inspection be also submitted, preferably on some form of "data card" as a guide to the interpretation of results (Fig. 38).

In sampling a water supply it is to be remembered that the laboratory work is in vain if the samples are not properly collected. Care should be taken that no impurities are added by using unsuitable containers improperly prepared; that samples are representa-

tive of the supply, and that they reach the laboratory in satisfactory condition.

In the early days of water analysis samples were collected and sent to the laboratory in old containers which had been previously

DATA CARD

Laboratories of the Provincial Board of Health, Ontario

WATER FOR ANALYSIS

Bottle Number

Sender's	Laboratory's

Reason for desiring an analysis ....

....

Name and Official position of person sending sample ....

.... Address ....

Municipality ....

Name of Medical Officer of Health

.... Address ....

Date of Collection .... Hour .... A.M. P.M.

How collected (directly or by dipper) ....

Source of water sample (lake, stream, pond, reservoir or well) ....

....

Depth at which taken ....

Total depth of water ....

Distance from shore at which taken ....

Temperature of water when taken ....

If from well, depth of? .... Depth of water in well?

.... Materials of wall or curbing

....

Is there a pump? Iron or wooden?

Does spout carry drip beyond edge of well? ....

How is well covered? ....

Is it a seepage, spring or flowing well? ....

....

What kinds of soil are found from surface to bottom? ....

....

At what distance is well from trees, vines, privies, stables, outhouses, kitchen doors, drainage from kitchen sink, or cesspools?

Please indicate in subjoined space by stars the relative position of well to objects mentioned above.

Here	So
	*Tree 20 ft. *Kitchen 25 ft. *Stable 80 ft. O Well *Privy 30 ft. *Vine 20 ft. *Pig Sty 25 ft.

Are there any slopes in the neighbourhood? ....

....

How are they situated in relation to well?

(Toward or away from object jotted down on diagram)

Name of owner of well ....

Rainfall during previous week (*i.e.*, in such terms as nil, small, or great in amount) ....

Remarks ....

....

....

DECLARATION

I ....

do declare this sample of water marked No. ...., sealed up by me and forwarded this .... day of ....

to be that collected as described in foregoing certificate.

Signed ....

Collector

Declaration made before me, a Commissioner of the High Court of Justice, this .... day of .... 19 .... *Com. H. C. of J.*

NOTICE

The above card is to be filled in fully and declared to for each sample sent in, otherwise the sample will not be examined.

The above data are necessary to enable a proper interpretation to be passed on sample and also for proper statistical purposes.

Fig. 38.

used for other purposes. The vinegar jug, candy or molasses jar, or liniment bottle was commonly used. That time is past. As it is now possible to obtain ground glass stoppered bottles of clear glass they should be used for this work. They are usually supplied

by the State and Provincial Boards of Health, and are usually sent from the laboratories upon request. For bacteriological examination six or eight ounces are sufficient; for a chemical analysis half a gallon or "Winchester" is required. Bottles are usually sterilized in the laboratory by heating for one hour at 160° C. and then capped with tin foil, rubber dam or oiled silk held in place by rubber bands. They should not be opened before the time of sampling. Care should be taken that the parts of the stoppers fitting into the necks of the bottles are not handled or allowed to touch anything while the bottles are being filled. Fill each bottle only to the neck, allowing some air space for expansion. As each sample is collected a distinguishing mark by which it can be identified should be attached. The most satisfactory way of doing this is to use a small card which can be placed in an envelope and tied to the neck of the bottle.

If the sample is to be collected from a tap, allow the water to run freely for a few minutes in order to clear the pipes. Then remove the stopper from the bottle, allow the water to fill in just to the neck, replace the stopper, cover with the oiled silk and secure it with the rubber band. Do not use paraffin or sealing wax.

In sampling the water of a well provided with a pump, operate the pump for a few minutes to clear the logs or pipes, then allow the stream from the spout to fall directly into the bottle. If there is no pump, tie the bottle to a clean new string or sterilized wire and lower it into the water and allow it to fill. If you use any utensils such as dippers or pails, make sure that they have been thoroughly cleaned and scalded before use and rinse them a few times with the water to be sampled. In sampling springs observe the same precautions.

In sampling a small stream, the bottle may be tied to a few feet of sterilized wire attached to the end of a pole. This same outfit is useful if the stream is large and a boat is employed. Care should be taken to note, preferably on a sketch map, the source of each sample as collected. One sample is not likely to be representative. The points at which the contamination is most probable should not be overlooked. In sampling a lake it is well to remember that you require more than one sample. In addition to the ordinary

channel currents, wind currents may carry sewage a considerable distance. The wire and pole method is ordinarily sufficient for the collection of samples representing the surface water to the depth of two feet. Occasionally samples from a greater depth are desired. If this is the case, apply to the laboratories for special apparatus. For description of several forms of the deep sampler, see Whipple's *Microscopy of Drinking Water.*

Specimens and data cards should reach the laboratories with the least possible delay. If the package is likely to be more than a few hours in transit, use cracked ice with the packing to lower the temperature and prevent alteration in the numbers of microorganisms present.

The period of time between the sampling and the laboratory estimation should be as short as possible. Alterations taking place in stored samples are of a biochemical nature associated with the growth of certain types of bacteria and the destruction of others. Such changes are greatest in highly polluted waters. While it is impossible to deduce mathematically that a sample is of no value because it has been over a certain time in reaching the laboratory, the following are suggested limits,[2] applying to ordinary conditions:

CHEMICAL ANALYSIS AND PHYSICAL EXAMINATION

Ground waters (shallow wells, springs)	72 hours
Fairly pure surface water (lakes, ponds, streams)	48 "
Polluted surface waters	12 "

BIOLOGICAL EXAMINATION

Microscopical Examination of Sediments

Ground waters	72 hours
Fairly pure surface waters	24 "
Waters containing fragile organisms	Immediate

BACTERIOLOGICAL EXAMINATION

Samples kept below 10°	24 hours
Samples kept at temperature higher than 10°	6 "

In warm seasons of the year samples should be packed in ice if they must be sent by express. If each bottle is rolled in paper a number of them may be packed in ice and sawdust without danger of breakage and usually reach the laboratory in good condition.

TEMPERATURE

For drinking purposes consumers generally prefer a water which is cool. It is estimated[3] that no one will object to an otherwise satisfactory water if it has a temperature of 45° F.; half the people will object at 66° F. and all will object at 75° F. Ice for cooling drinking water is too expensive for general use, and consequently

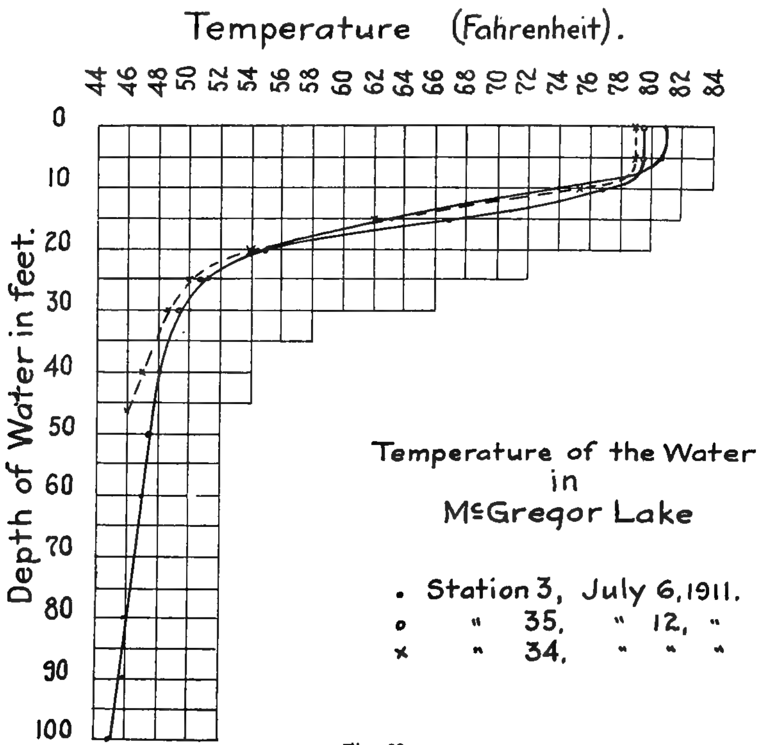


Fig. 39.

if several sources of water supply are available the one which provides a cool water is to be preferred, other things being equal.

The temperatures of the different portions of a body of water such as a pond or lake have a great bearing upon its general character. This is brought out in the science of *limnology*,[4] which deals especially with the study of ponds, their bacteriological, geological, and physical features, and their interrelationships. In northern

lakes it is found that the temperature conditions at various depths are relatively different in the summer and in the winter months. In the summer months it is usual to find the temperature of the surface water higher than that at depth; the upper ten feet will commonly show the same temperature; there will be a sudden drop in temperature in passing from the ten-foot level to the fifty-foot level; at greater depths the temperature is fairly constant. (Fig. 39.) In early winter, before the surface is covered with ice, the surface water is colder than that at depth—the reverse of the summer stratification.

The density of water at 4° C. (39.2° F.) is unity (our basis of specific gravity). At temperatures below and above 4° C. the density is less than unity. (Table LIX.) As water which is specifically

TABLE LIX

RELATIVE DENSITY OF WATER AT VARIOUS TEMPERATURES

(The mass of 1 c.c. water at 4°C. is taken as unity)

TEMP. (C°)	DENSITY	TEMP. (C°)	DENSITY
0°	0.99987	7°	0.99993
1°	0.99993	8°	0.99988
2°	0.99997	10°	0.99973
3°	0.99999	15°	0.99913
4°	1.00000	20°	0.99823
5°	0.99999	30°	0.99567
6°	0.99997	40°	0.99224

heavy tends to sink, this gives rise to vertical circulation when the layers of water are at different temperatures. In the summer months, the upper layers are the warmer. During the winter, the bottom layers are warmer than the surface layers. When the air temperature is 39.2° F. the water in contact with it becomes cooled to that temperature, and the surface water, then at maximum density, settles rapidly to the bottom. This vertical circulation gives rise to the reverse in stratification, referred to as the "turn over." It is encountered in spring and in fall, and because of the stirring accompanying it, is likely to create special difficulties for filtration plants at such times.

The thermophone[a] is an electrical instrument for measuring the temperatures at various depths in a body of water. As it is rather

expensive many make use of a less convenient but sufficiently accurate device. A thermometer which need not be very accurate, permissible error being 0.1°, is encased in a block to protect it from breaking, and placed in a large bottle provided with means of

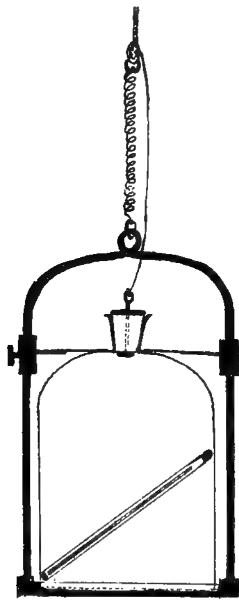


Fig. 40.—Diagram of apparatus which may be used (if a thermophone is not available) for determining temperatures in a body of water at depth. The bottle is 3/4 gallon size; stopper is of cork or rubber and penetrated by a stout eye bolt, thermometer with scale etched on the glass is protected by a wooden block made from an old thermometer case. When the bottle has been lowered to the desired depth, a jerk on the rope extends the coiled spring and the stopper is removed. This device, originally designed by Whipple, is useful in collecting samples for microscopical examination. The frame is of brass and heavily weighted at the base.

lowering it to any desired depth and of removing the stopper at that point. The filled bottle does not change its temperature very rapidly so that thermometer readings made after hauling to the surface are not greatly in error. (Fig. 40.)

COLOR

The natural color of pure water is slightly greenish when observed in deep layers. Various shades of amber are noted in the waters of many of our lakes and streams. Color in water is primarily caused

by particles in colloidal suspension, the various shades being dependent upon the sizes and numbers of such particles. Under the influence of reflections from the bottoms, and from the sky, many other effects may be obtained. By viewing the water in tubes, these optical effects may be avoided and comparison made with standard colors.[2] These colors are made up to avoid the necessity of using descriptive adjectives such as "rather colored," etc. In deciding upon a standard it was necessary to use some material of definite composition, easily obtained in a high state of purity and to have the color shade match that of many waters. Potassium platinic chloride (K_2PtCl_6) gives a yellow solution; cobalt chloride

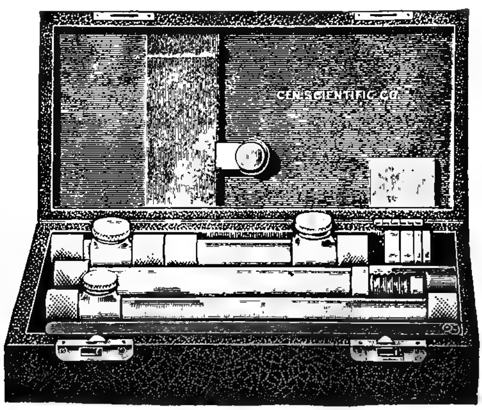


Fig. 41.—Field outfit for the determination of color and turbidity.

($CoCl_26H_2O$) gives a pink solution. The two blend to give a brown. The standard color of 500 contains 1 g. cobalt chloride with 1.246 g. potassium platinic chloride, and 100 c.c. concentrated hydrochloric acid per liter. Others ranging from 10 upward are made by diluting this. These standards are matched by colored glasses prepared for use in colorimetric apparatus. The Lovibond tintometer has in its extensive assortment of colored glasses one set for color in water. This is a very expensive apparatus and not very commonly used. The simple form of field apparatus[6] designed by Hazen and sold with the turbidity rod in an assembly is very useful (Figs. 41 and 42). The water to be examined is placed in colorimetric tubes with clear glass

ends and the color matched in another tube to which the shaded color disks of glass may be applied in various combinations.

As stated above, color in water is usually caused by colloidal matter in suspension or solution. In fact the problems of color and its removal are essentially problems in colloid chemistry. Apparent color, removed by filtration through paper, is most usually caused by hydrated oxide of iron. True color is not removed by filtration through paper and might be caused by organic matter in true solution, in colloidal solution, and colloidal suspension. Tannins, humic and ulmic acids are extracted from bark, dead leaves and grass. The term "log juice" applied to our rivers used in the lumbering industry is associated with the production of color. The so-called "meadow teas" of New England owe their color to vegetable matter. Whether or not the consumers object to a colored water is largely a matter of

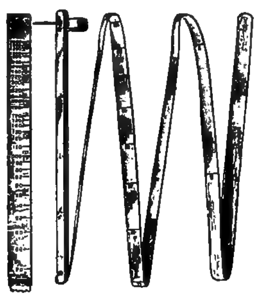


Fig. 42.—The turbidity rod of the U. S. Geological Survey.

custom. It is estimated[3] that 50 per cent of the people will object to an otherwise satisfactory water if it has a color of 100; 20 per cent will object to a color of 40. Color may be removed in reservoirs by the action of sunlight and the gradual coagulation of colloidal particles taking place during storage. Complete removal of color by filtration is often a matter of more difficulty and if other features are satisfactory, a filtration plant aims at reducing the color to a practical limit of about 30 on the standard scale.

TURBIDITY

Turbidity in natural waters is due to finely divided particles of matter in suspension. It is possible to have clay, sand, or organic

matter in all states of subdivision intermediate between gross particles, which settle out readily, and the very finely divided colloidal particles, which approximate true or ordinary solution. Instead of using descriptive adjectives such as "rather turbid," "decidedly turbid," "very turbid," etc., analysts refer to the different degrees of turbidity as numbers on a scale which has been established.

The turbidity rod of the United States geological survey is a field instrument.[6] The eye is placed at a fixed distance from a platinum wire of certain gauge and the numbers indicate the limit of visibility of the wire. In the laboratory, use is made of a silica standard. It has been agreed by convention[2] that a 0.1 g. portion of Fuller's earth (Pears) dried and passed through a 200-mesh wire sieve, when suspended in a liter of water gives a suspension with turbidity of 100. Other values are obtained by diluting this suspension with known amounts of distilled water. The turbidity of a sample is determined by comparing it with these turbidity standards in tubes or bottles by observing the distinctness with which an object can be viewed when the observer looks through the sample and through the turbidity standard in similar vessels. Other more elaborate devices known as diaphanometers and turbidimeters have not come into general use.

Turbidity in itself is not very objectionable from the health standpoint. There is not likely to be intestinal irritation from the finely divided mineral matter. Whether or not people object to turbidity is largely a matter of usage. It is estimated[3] that 50 per cent of the consumers would object to water if its turbidity reached 100 on the scale referred to; 20 per cent would object to a turbidity of 20. Turbidity presents a problem for the filtration plant. It influences the working of filters, affecting the dosage of alum and frequency of back washing. As a general rule, if the turbidity of a water is due to organic matter, even in part, the dosage of chlorine for emergent chlorination must be increased.

TASTES AND ODORS

The purest distilled water has no odor and its taste is ordinarily described as "flat." Aeration removes this objection and also gives it a sparkling appearance. Water very readily takes up substances

which give it objectionable tastes and odors of different kinds described as vegetable, aromatic, grassy, fishy, earthy, moldy, musty, peaty, sweetish, etc. The intensity may be indicated by such terms as faint, distinct, decided, or very strong.

Saline tastes may be caused by salts such as chlorides and sulphates of mineral origin. Iron, if present in quantity, imparts a peculiar and characteristic taste, especially noticeable to those unaccustomed to it. Hydrogen sulphide of mineral origin is objected to by the majority of consumers. Trade wastes such as those from gas works and wood distillation plants, even when very highly diluted, carry a carbolic or a creosote taste. But the tastes and odors caused by microscopic organisms are much more frequently encountered. These simple plants and animals, very low in the scale of life, present a variety of forms[4] and many of them produce characteristic odors. Uroglena (a protozoon) gives a fishy odor; Asterionella (a diatom) a rose geranium odor; Anabaena (one of the blue green algae) a pig-pen odor. These are a few typical examples. The simple plants, generally referred to as the Algae, differ in many respects from the higher forms of vegetation. For food supply they require only carbon dioxide and such nitrogenous and saline compounds as are present in the majority of natural waters. Sunlight, moderate temperatures, and stagnation are favorable factors in the environment. Optimum conditions are, therefore, commonly prevailing only in ponds, small lakes, and reservoirs, in which the circulation of the water is poor. The summer months produce favorable temperatures and for this reason tastes and odors from such sources are more commonly met with in late summer and in the fall.

Although the most objectionable odors are those of decomposition and are due to compounds of sulphur and phosphorus produced when masses of vegetable growths die and break down, still some very persistent and undesirable flavors are produced by the organisms during life. Some of the diatoms for instance develop within their cells oily droplets which are liberated when disintegration takes place. The amount of such taste-producing oily material present in water is very small, often only a fraction of a pound per 100,000 gallons of water. In a water containing as many as 100,000 Asterionella per cubic centimeter the total organic matter is less

than 0.01 grams. There is no proved case of toxicity recorded in this connection, but it is, nevertheless, a very common source of troublesome complaints from the consumers. While aeration is to some extent a remedial measure, filtration is only partially successful; chlorination often aggravates the condition, tastes being noticed in the chlorinated water when neither the taste caused by organisms nor by the chlorine alone would be noticed separately, but the combination of the two produces very unpleasant results.

Growths in reservoirs may be kept down and controlled to some

ONTARIO

LABORATORIES OF THE PROVINCIAL BOARD OF HEALTH

TORONTO,

Chemical Report

Specimens of

Received from of

on the day of 192

in parts per million

Laboratory Number	Sender's Number	SOURCE	Color	Turbidity	Total Solids	Chlorine (As Chloride)	HARDNESS			NITROGEN				Oxygen Consumed
							Total (Soap Consumption)	Temporary (Alkalinity)	Permanent	Free Ammonia	Albuminoid Ammonia	Nitrites	Nitrates	

Remarks

Fig. 43.

extent by employing copper sulphate which has a strongly algicidal action. The amount to be applied varies with different biological forms. Dosage should be carefully decided upon.[4] The copper does not appear in the treated water but is first precipitated as carbonate and finally separates out as oxides upon the sides and bottoms of the reservoirs. The dead plants must be removed by mechanical means.

The treatment is by no means as simple as it is commonly believed

to be; a partial dose may destroy certain forms but with such alterations in the flora other more undesirable forms may prevail and the improvement noticed may be small and only temporary. Fish life is also sensitive to copper poisoning and in attempting to apply this treatment to a body of water such as a pond, excessive dosage is to be avoided for this reason. The best measures to adopt are, therefore, to avoid tastes and odors as far as is practicable; to prevent the discharge of tar or creosote waters in the vicinity of water intakes; to choose a source where growths are not likely to occur and to keep reservoirs dark and cool.

Tastes and odors of a water may be observed in the field, although the laboratory tests are, as a rule, more elaborate and complete. The complex compounds of unknown composition and causative of taste may be liberated when the cells are broken up. Odors of putrefaction may be more intense than those of other types. It follows that a water is often worse when drawn from taps in the distributing system than in the reservoirs, and samples which have been thoroughly shaken in shipment or stored for a considerable interval before the examination is made may appear worse in the laboratory than in the field.

THE CHEMICAL ANALYSIS (SANITARY)

A typical report form giving the results of the chemical analysis of water is shown in Fig. 43. These laboratory tests are to be dealt with in a general way, with a view to showing the principles underlying them and their significance. For working details of carrying out these processes, it is necessary to consult the laboratory manuals.[2, 7, 8] The official methods of the American Public Health Association are an excellent guide and are sufficiently flexible for adaptation to various conditions.

Results are usually expressed in parts per million (p.p.m.). This is convenient because of the general use of the metric system of weights and measures in the laboratory. One liter of distilled water at 4° weighs 1000 grams. The deviation in the case of natural waters is of comparatively small importance. For all practical purposes a liter of a water sample contains a million milligrams, and consequently figures expressing amounts of any constituent in milli-

grams per liter of sample are the same as those giving parts per million.

In calculations involving quantities otherwise expressed, the following factors are useful:

Grains per Imperial gal. $\times$ 14.3 = parts per million (p.p.m.).

Grains per U. S. gal. $\times$ 17.1 = p.p.m.

The Imperial gal. of water weighs 10 lbs. or 70,000 grains.

The U. S. gal. of water weighs 8.3389 lbs.

The gallon, New York statute measure, weighs 8 lbs.

TOTAL SOLIDS AND LOSS ON IGNITION

Total solids are determined by evaporating a known volume of water to dryness on the water-bath in a tared dish—preferably of platinum, but porcelain may be used. Drying may be finished in an oven at 103 to 105 degrees. Since an accurate chemical balance is used, it is not necessary to evaporate a large volume of water. As little as 0.0200 g. of residue can be weighed accurately. The chief value of the figures obtained is for purposes of comparison or of proving the identity of a water. It is not possible to establish any definite standard of solids to which waters must conform in order to be considered of satisfactory quality. When the residue is heated to dull redness it loses water of crystallization, organic matter, and carbon dioxide from carbonates. All these are included in the loss in ignition. With large amounts of organic matter there is considerable charring from the liberation of carbon. The odor given off during heating may in special cases indicate to the analyst the source of such organic matter. Although it is one of the oldest tests in water analysis it is not by any means conclusive from the sanitary standpoint. There may be heavy charring and odor from a residue obtained by the evaporation of a water containing large amounts of vegetable matter which is harmless in itself and not indicative of dangerous contamination.

CHLORINE AS CHLORIDE

This refers to the chlorine combined with metals such as sodium, calcium, and magnesium in the form of salts, and is to be distinguished from the free or elemental chlorine which is used for dis-

infection. Practically all natural waters contain chlorides obtained from sea spray, from the soil or from the other layers of the earth's crust with which they come in contact. Rain water falling in districts near the seashore carries saline material borne in the form of spray. Soluble chlorides are found in many geological formations, especially in certain districts where inland seas of ancient date have been concentrated to heavy brine or to complete dryness, leaving mineral salt beds. The amount of chloride present in the ground waters of a district will, in general, be characteristic of the waters of that locality. This is referred to as the '''normal'' chlorine. Charted on maps it gives us so-called ''isochlors'' or lines drawn through points having the same normal chloride.

The isochlors of states or provinces bordering on the ocean are generally more or less in conformity with the coast line.[7, 8] In other parts the lines are more irregular, especially where there are salt deposits. In the vicinity of Toronto, Canada, there are wells varying in depth from 20 to 200 feet, penetrating the Medina or the Clinton Shales, which carry up to 2000 p.p.m. of chloride, chiefly calcium chloride.

These salts are not injurious in themselves, although they give a decided taste to the water if present in large amounts. It is estimated that seven persons in one hundred can taste 200 parts of salt (sodium chloride) in 1,000,000 parts of water. The chief reason for determining the amount of chlorides present is to collect evidence as to the possibility of contamination with sewage. The salt which we eat passes from our bodies unchanged in its chemical nature or amount. The 1500 cubic centimeters of urine passed daily by an adult normally carries about 15 grams of sodium chloride. If, then, a water is found to contain a larger amount of salt than is usual in waters of that district, we suspect sewage contamination. It may be due to other causes—from stables, from trade wastes, from tanneries or refrigeration plants. In case of abnormally high chlorine we must, therefore, depend upon the sanitary inspection to decide as to the source of the saline material. This test frequently indicates potential danger of infection, even when the bacteriological test is negative, because the presence of the organisms may be intermittent either through irregularities in the infection itself or in the operation of natural filters which remove them part of the

time. The test is of value in proving the identity of a water; leaks in distributing systems have been detected thereby. The determination of chlorine as chloride is carried out by titration with standard solution of silver nitrate. Since it requires but little time and material, and thus often supplies a considerable amount of information with very little cost, it is often included in routine reports which are otherwise entirely bacteriological. The gradual increase of the chloride content of waters with increase of population in the watershed and tributary streams is shown by waters of the Great Lakes. The chloride is noticeably higher in the vicinity of the larger cities on the Lakes. In Toronto water the increase in chloride may have been partly from trade wastes but is largely from sewage. In 1881, 1886, 1891, 1911 and 1921 the amounts were 3.0, 3.0, 4.0, 9.0 and 12.5 p.p.m. respectively.

OXYGEN CONSUMED

Oxygen consumed (oxygen absorbed, oxygen required) is estimated by heating with potassium permanganate. Results are dependent upon various factors such as concentration of reagents, temperature, and time. It is one of the best examples of an empirical process, giving results which are of comparative value if the same procedure is consistently followed. Over fifty different modifications of this process are described in the literature and are referred to in Standard Methods of the American Public Health Association. Many laboratories carry out the process by heating in a porcelain casserole 100 c.c. sample with permanganate sufficient to give a decided permanganate color. This color is maintained by adding additional permanganate if necessary, while the contents of the casserole are heated to boiling point for five minutes. The amount of permanganate used up is estimated by adding excess standard solution of oxalic acid[7] or of ammonium oxalate, more than is necessary to decolorize completely, and titrating back with standard permanganate. The test may be interfered with by iron, or by hydrogen sulphide, but in absence of such interferences, indicates organic matter. Attempts to distinguish various forms of organic matter by modifying or elaborating some one of the 50+ variations of this test have not proved very successful.

NITROGEN

Nitrogen may be present in natural waters in the form of free ammonia, ammonium salts, complex nitrogenous organic compounds, nitrites, and nitrates. The methods of determining these various forms are subject to considerable variation and are consequently made more satisfactory by standardization as has been done by the American Public Health Association. Nitrogenous organic matter may be decomposed and the nitrogen therein estimated by the well-known Kjeldahl method but the processes described below are those most commonly used. For working details the books giving those procedures must be consulted,[2, 8, 9] but the general principles underlying them may be outlined here. The nitrogen itself is not a dangerous impurity, but is taken as an index of possible pollution.

NITROGEN AS AMMONIA

Ammonia in solution can be estimated colorimetrically by means of Nessler's reagent prepared from mercuric chloride, potassium iodide and caustic potash. The direct application of the reagent to water samples gives only approximate and often very unsatisfactory results. In the majority of cases the ammonia must be distilled off. For distillation, the apparatus shown in Fig. 44 is satisfactory. The flask is first charged with distilled water and pumice to prevent "bumping." The distillate is then tested with Nessler's reagent at intervals until a test shows that the apparatus is ammonia-free. This is often a matter of some difficulty, especially with older types of apparatus. The flask is then disconnected and charged with the sample; sodium carbonate is added (to facilitate the decomposition of ammonium salts such as the chloride, which otherwise decomposes rather slowly) and the distillate collected in Nessler tubes. Usually four tubes, 50 c.c. each, are collected and the amount of ammonia in each is estimated by comparison with a set of standard tubes prepared from a solution of ammonium chloride, the concentration of which is accurately known.

ALBUMINOID AMMONIA

An alkaline solution of potassium permanganate is then added and the distillation continued. This reagent breaks down complex

nitrogenous compounds and this second distillate contains ammonia referred to as "albuminoid ammonia." It is also possible to determine the free and albuminoid ammonia together from a distillation with alkaline permanganate, and to obtain the albuminoid ammonia by difference, the free ammonia being determined on a separate portion of the sample.

The test for free and albuminoid ammonia is one of the very old

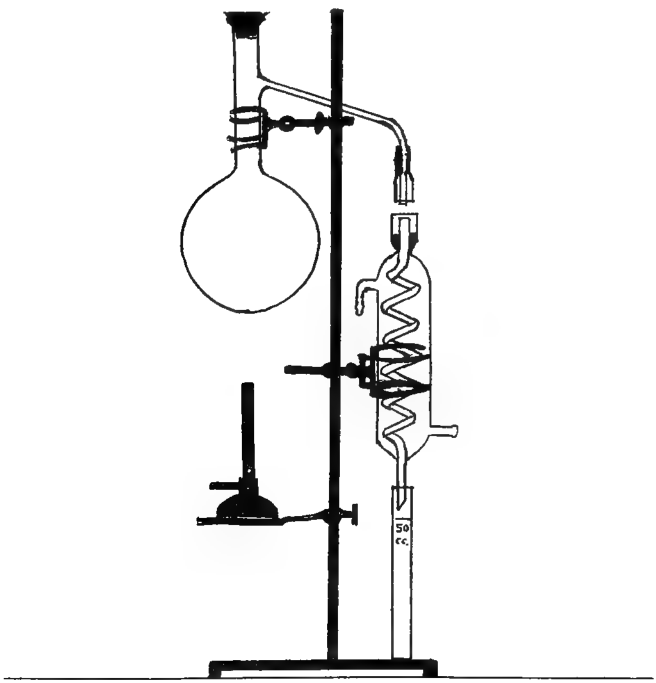


Fig. 44.—Apparatus for the distillation of free and albuminoid ammonia. The Pyrex distillation flask is fitted with a rubber stopper covered with tin foil; the side tube of the flask is connected by means of a rubber sleeve with a glass tube which slides into the mercury cup of the spiral condenser; Nessler tubes are placed to collect the distillate.

tests in water analysis. In itself it is inconclusive because, as will be noted, the nitrogenous compounds dealt with may have several possible origins or sources. Free ammonia and ammonia salts may come from the decomposition of animal excreta, from animal remains, plant remains, or from reduction of nitrites and nitrates. The high figures for free ammonia obtained in deep well waters are from the

last mentioned source. If a water has been analyzed a sufficient number of times to establish a standard analysis for that particular water, it has been observed that the content of free and saline ammonia runs fairly parallel with the bacterial count. This chemical test, along with the turbidity determination, is of assistance in controlling the operation of a filtration plant. Some hint as to the origin of the ammonia may be obtained from observation of the rate at which the ammonia is given off as judged from the amounts found in each of the four tubes. The nitrogen as albuminoid ammonia may come from animal excreta, animal remains, or from plant remains. As a rule vegetable matter gives off its nitrogen more slowly than does the animal matter, but it is not possible to rely entirely upon this to make a definite pronouncement.

NITRITES

Nitrites are best estimated colorimetrically by means of two organic reagents, alpha naphthylamine and sulphanilic acid in acetic acid or hydrochloric acid solution. These give a red coloration with small amounts of nitrite and the amount may be estimated by comparison with the intensity of color produced in similar tubes containing known amounts of nitrite. This is an exceedingly delicate test, so delicate in fact that several gas flames burning in the room will produce enough nitrite from the atmospheric nitrogen to interfere with the test. Nitrites may come either from the oxidation of ammonia or from the reduction of nitrates; and their presence in a water indicates instability because of the biochemical changes taking place.

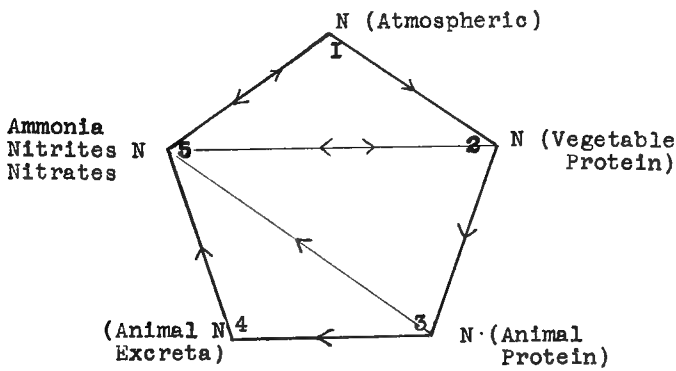
NITRATES

Nitrates may be determined by the phenoldisulphonic acid process—this reagent giving a yellow coloration which may be employed in colorimetry. Nitrates may be of mineral origin and may be objectionable if in excess of about 10 p.p.m. Smaller amounts are not likely to be injurious. Nitrates, if formed from nitrites, indicate that at some time in the rather remote past, the water contained nitrogenous organic matter and, therefore, give evidence regarding the past history of the water. It may be that a natural oxidizing filter

has been operating satisfactorily. For the clear understanding of chemical analysis of water and of sewage disposal there is no one feature which is of greater importance than is the "nitrogen cycle."

NITROGEN CYCLE

The term "nitrogen cycle" refers to the recurring series of changes in which nitrogen takes part, as it plays its rôle in the life processes of plants and animals (Fig. 45).



THE NITROGEN CYCLE

Fig. 45.

N① Atmospheric, 79 per cent of the air. It is inhaled by animals and exhaled unchanged. A few plants use it to build up tissues.

N② Vegetable protein, an essential constituent of protoplasm and necessary for life.

N③ Animal protein, an essential constituent. Muscle (dried) contains 16 to 17 per cent nitrogen.

N④ Excretion of nitrogenous waste as urea, creatine, etc., never ceases during the life of the animal. Urea, $C{=}O(NH_2)_2$ is present in human urine, (about 2 per cent).

N⑤ (a) Ammonia and ammonium salts.
(b) Nitrites (salts of nitrous acid, HNO_2).
(c) Nitrates (salts of nitric acid, HNO_3).

Arrows in the diagram indicate the courses of the chemical reactions producing the transmutations of the various forms.

N①→N② Certain plants, such as the leguminosae (pea, bean, and clover family, are able to build up nitrogenous tissues utilizing atmospheric

nitrogen. They do this through the action of nitrifying bacteria which grow in masses at the roots.

N② → N③ Herbivorous animals eat nitrogenous plants. By the process of digestion they break down the protein by hydrolysis into peptides and amino acids. These compounds are absorbed from the intestine and used in the building up of animal protein essential to growth and repair.

N③ → N④ During life the discharge of nitrogenous waste never ceases. The amount depends on many factors such as growth, diet, and activity.

N② → N⑤ The chemical changes taking place during the decay of plant remains are biochemical, the microorganisms effecting hydrolysis of protein into simpler compounds. Protein → proteoses → peptones → peptides → amino acids → ammonia and ammonium salts.

N⑤ → N② Plants utilize ammonium salts, nitrites and nitrates as food.

N③ → N⑤ Decomposition of animal remains is effected by reactions similar to ② → ⑤.

DENITRIFICATION

A. Nitrites and nitrates are changed to ammonia by "Bacterium denitrificans II".

B. Nitrates are changed to nitrites by at least 85 different organisms.

C. $$\underset{\text{nitrite or nitrous acid}}{2HNO_2} + \underset{\text{(urea)}}{C\begin{array}{l}\diagup NH_2\\ =O\\ \diagdown NH_2\end{array}} \rightarrow CO_2+N_2+3H_2O.$$

This is a chemical change which takes place rapidly, and is independent of bacteria.

N⑤ → N① $$\underset{\text{(sugar)}}{5C_6H_{12}O_6} + \underset{\text{(potassium nitrate)}}{24KNO_3} \rightarrow \underset{\text{(potassium bicarbonate)}}{24KHCO_3} + 6CO_2 + 18H_2O + 12N_2$$

There are organisms known as "Bacterium denitrificans V & VI" which effect this change, decomposing nitrate and giving free nitrogen.

Reactions A, B, C, and ⑤ → ① together constitute "Denitrification."

N① → N⑤ This is the oxidation of atmospheric nitrogen by electrical discharges or by combustion of moist air.

NITRIFICATION

N④ → N⑤ $$\underset{\text{(urea)}}{C\begin{array}{l}\diagup NH_2\\ =O\\ \diagdown NH_2\end{array}} + 2H_2O \rightarrow \underset{\text{(ammonium carbonate)}}{(NH_4)_2CO_3}$$

1. This change is biochemical, associated with growth of microorganisms which utilize urea as food and produce ammonium carbonate. Several such bacteria are known. "Bacterium ureae" first of these isolated. Some of the organisms are bacilli, others are micrococci, many are facultative. The enzyme "urase", excreted at death of the organism, also effects the change.
2. $NH_3 + 2O_2 \rightarrow HNO_2 + H_2O + O$. Certain aerobic bacteria change ammonia and ammonium salts to nitrites. "Nitrosomonas" and "Nitrosococcus" are two types of which there are several species.

3. $HNO_2 + O \rightarrow HNO_3$. Other aerobes, of which there is only one well-defined genus, change nitrites to nitrates.

The chemical changes 1, 2, and 3 together constitute "nitrification".

SULPHUR CYCLE

Sulphur accompanies nitrogen as an essential constituent of many proteins. It likewise passes through a series of chemical changes which are cyclic in recurrence. This cycle is not of the same interest or of as great importance as is the nitrogen cycle.

HARDNESS

The hardness of water is due to mineral constituents, chiefly calcium and magnesium, which form insoluble compounds with soap. Certain geological formations contain chlorides and sulphates of these two metals, and these salts, being quite soluble in water, are readily dissolved. Again, when a water charged with carbon dioxide obtained from the air or by the oxidation of organic matter commonly of vegetable origin flows over a bed of limestone it exerts a solvent action, the lime going into solution as bicarbonate.

$$CaCO_3 + H_2O + CO_2 \rightleftarrows Ca(HCO_3)_2$$

This is a chemical equilibrium, easily disturbed by changes of temperature, concentration and tension of carbon dioxide. The bicarbonates, which are soluble, are readily decomposed by boiling, the carbon dioxide being expelled and the carbonates almost completely precipitated. Similar reactions take place with magnesium carbonate. This hardness removed by boiling is known as *temporary* hardness. The hardness not so removed is called *permanent* hardness. Permanent hardness is caused, therefore, by the residual carbonates, chlorides, sulphates and nitrates of calcium, magnesium, iron and other metals which may form insoluble precipitates with soap. The reaction with soap may be indicated in general terms, thus:

$$\begin{array}{l}\text{Calcium}\\ \text{Magnesium}\end{array}\left\{\begin{array}{l}\text{Bicarbonate}\\ \text{Carbonate}\\ \text{Chloride}\\ \text{Sulphate}\\ \text{Nitrate}\end{array}\right. + \underset{\text{(Ordinary hard soap)}}{\text{Sodium}\left\{\begin{array}{l}\text{Oleate}\\ \text{Stearate}\\ \text{Palmitate}\end{array}\right.} \rightarrow \text{Sodium}\left\{\begin{array}{l}\text{Bicarbonate}\\ \text{Carbonate}\\ \text{Chloride}\\ \text{Sulphate}\\ \text{Nitrate}\end{array}\right. + \underset{\text{(Insoluble soap)}}{\begin{array}{l}\text{Calcium}\\ \text{Magnesium}\end{array}\left\{\begin{array}{l}\text{Oleate}\\ \text{Stearate}\\ \text{Palmitate}\end{array}\right.}$$

The cleansing action of ordinary soap is due largely to its colloid properties which enable it to form emulsions. This is interfered with by the above reactions. Until the calcium and magnesium salts are removed by precipitation there is no permanent lather and the cleansing action of the soap is not effective. Moreover, large amounts of lime and magnesium soaps ordinarily form a curdy precipitate with water and have an unpleasant effect on the skin. It is estimated[3] that in softening a hard water every 10 p.p.m. of hardness adds one hundred dollars to the cost per million gallons of water softened with soap. A community using a very hard water therefore suffers an economic loss.

Industrially, hardness interferes with many processes such as dyeing and canning. In steam boilers, domestic heaters and hot water systems there is difficulty from scale formations, caused largely by the decomposition of the compounds concerned with temporary hardness. The incrustation not only causes loss in heating efficiency but increases the danger of explosion.

Hardness is of importance, therefore, from the economic standpoint although it has not been proved that very hard water tends to the formation of calculi in the body, or that very soft water has a decalcifying action. An exceedingly hard water is to be avoided if possible. This is well illustrated by the experience of Winnipeg.[12] The supply formerly used was exceedingly hard well water. The hardness was an important factor in deciding to draw upon another source ninety miles distant, at a cost of many millions of dollars.

WATER SOFTENING

Temporary hardness may be in greater part removed by treatment with lime. $Ca(HCO_3)_2 + H_2O + CaO \rightarrow 2CaCO_3 + 2H_2O$. The quicklime is added to combine with the carbon dioxide which is the solvent. Magnesium carbonate is less satisfactorily removed. Calcium chloride and sulphate are precipitated by soda ash; $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$. For satisfactory removal of magnesium, sufficient lime must be added to precipitate it as the hydroxide $Mg(OH)_2$. The standard process for water softening employs the above reactions. In beginning operations a complete mineral analysis[2] of the water should be made. With careful operation many

waters may be treated satisfactorily but in other cases, especially with magnesium waters, results are often far from perfect. It is always to be remembered that sodium compounds replace those of calcium and magnesium. For this reason the lime and soda ash treatment is not applicable to very highly charged mineral waters containing large amounts of calcium and magnesium chlorides and sulphates.

Permutit.—It was noticed that hard waters flowing through certain volcanic rocks (zeolites) were softened thereby. The essentials of the reaction are shown in equation form with a chloride water, for example: $Na_2O.Al_2O_3.2SiO_2.6H_2O + CaCl_2 \rightarrow CaO(Al_2O_3.2SiO_2.6H_2O) + 2NaCl$.

An artificial zeolite, a furnace product known as "permutit," is used to soften waters by exposure to it in tanks. The effluent obtained is of zero hardness but contains sodium salts which may be objectionable, causing priming and foaming in steam boilers, or a taste if brines are used. The permutit may be regenerated by treatment with brine—practically effecting a reversal of the above reaction. Back-washing with brine must receive careful attention. The permutit process has been found valuable for complete water softening of moderately hard waters to be used for special industrial purposes, but is not regarded as a perfect answer to the problem of softening a very hard water.[9] The permutit process is generally more expensive to operate than the lime and soda ash process, but has the advantage of being self-adjusting in the case of a water of varying hardness.

OTHER PROCESSES FOR WATER SOFTENING

Trisodium phosphate is an excellent precipitant for calcium and magnesium and is used to some extent as a water softener. The great disadvantage is in the high costs. The salt is marketed in the form of crystals, the composition indicated by the formula $Na_3PO_4.12H_2O$.

BOILER COMPOUNDS

The use of boiler compounds prepared from widely variant materials such as molasses, starch, tannic acid, and water glass, is

rather questionable. Even if the lime and magnesia are prevented from precipitating or are thrown down in a colloidal nonadherent form, there is in some cases loss from frequent blowing off to get rid of accumulated sludge. There is also possible danger from increased corrosion.

DETERMINATION OF HARDNESS

Although there are comparatively few municipal water softening plants in operation, there is a possibility of greater attention being paid to this question, which is largely an economic one, as the countries develop. Hardness is usually expressed in terms of parts per million calcium carbonate, even if present as calcium chloride, magnesium sulphate or chloride. It may be determined by a variety of methods. The soap test is valuable, although not scientifically accurate. It certainly indicates the "soap-consuming power" which is of importance to the householder. A solution of soap is made by dissolving castile soap in diluted alcohol, and standardized by shaking after repeated small additions of a solution of calcium chloride prepared by dissolving one gram of calcium carbonate in hydrochloric acid and diluting to one liter. The first few portions of calcium chloride solution added produce a turbidity caused by the insolubility of the calcium soap formed. This gradually increases in amount until nearly all the calcium has been thrown down. When this has been accomplished the addition of more soap solution gives, on shaking, a permanent lather. This formation of a lather which persists for a few minutes is taken as the end point. It is not comparable in accuracy to many of the titrations employing indicators such as phenolphthalein or methyl orange. However, in experienced hands it gives fairly consistent results. Precautions must be taken to add the soap solution gradually and to shake at about the same rate each time. A portion of the sample of water is then placed in the bottle and soap solution gradually added as before until permanent lather is formed. Magnesium waters are liable to give false end points because of the physical form in which the magnesium soaps are precipitated. As mentioned above, a complete analysis of the mineral water is advisable before a softening process is attempted.

IRON

Many natural waters contain iron in either the ferrous or the ferric form or both. Iron is very widely distributed in rocks, the mineral sulphide (pyrite) being almost universal. Under certain conditions this sulphide is readily oxidized to sulphate and taken up by ground waters. It may appear later on in the form of carbonate or colloidal hydroxide, imparting a brownish color to the water and separating out as a brown sediment when the water stands. Iron may also enter into complex chemical combinations with organic matter.

In addition to the iron present in natural waters there is the iron obtained from the corrosion of storage tanks and distributing systems. The corrosion of iron presents many complexities[10] and is often connected with electrical forces. The total amount of iron present may be determined colorimetrically with thiocyanate, and is expressed in parts Fe per million. Iron in a water causes trouble in the laundry because of the rusty stains deposited on fabrics. Biologically it favors the growth of certain microorganisms of which Crenothrix is the most common. This is a filamentous plant with a gelatinous sheath which sloughs off the debris interfering with operation of valves, taps and meters.[11] Iron interferes too with certain industrial processes such as tanning, canning and brewing. It is rather doubtful if iron in drinking water causes any injury to health. It has been stated, however, that in amounts greater than 4 p.p.m. it tends to cause constipation. There is a very objectionable taste associated with iron, especially in some of its forms of organic combination.

The removal of iron, or "deferrization,"[13] is important in some places. This process depends upon a precipitation as ferric hydroxide, and may be effected in some cases by simple aeration and sedimentation. Other waters require the addition of lime. Crenothrix can be destroyed by treatment with bleaching powder, liquid chlorine or chloramine. A great deal can be done to prevent corrosion of water mains by avoiding "dead ends" or other features favoring poor circulation. Electrolysis may be very troublesome locally and necessitate location and removal of the stray currents. Street railways in which the bonding of the rails is poor are a common source of such currents.

MANGANESE

Manganese is not so commonly encountered as is iron, but is frequently associated with it and appears to present similar problems in certain localities.

ZINC

Zinc is sometimes found in drinking water as a consequence of the solvent action exerted upon the galvanizing of pipes and tanks. Soft waters containing large amounts of carbon dioxide and organic matter strip galvanized coatings, the zinc going into solution as carbonate. Disturbances of health from this source are rather obscure and often overlooked.

LEAD

Lead piping in water distributing systems may be a source of danger because it is attacked by certain types of waters and the continued ingestion of small amounts of lead produces serious systemic disturbances. Plumbosolvency of a water may be estimated by exposing sheets of lead to its action and determining the amount dissolved, using the standard methods[2] which are also applicable to water samples in which the presence of lead is suspected. Soft waters containing carbon dioxide are most likely to dissolve lead. After lead piping has been used for some time it becomes coated with carbonate and oxide and this coating protects it to some extent from further action.

BACTERIOLOGICAL EXAMINATION

In the bacteriological examination of waters the official methods[2] should be followed in detail. It is to be remembered that no single culture medium or set of conditions can give an accurate estimate of all the different forms present. In such circumstances it is advisable to adhere to established procedure,[2, 16] disregarding any portion of the flora which may not appear.

Briefly these methods consist of a cultivation on gelatine and agar media in petri dishes for the enumeration of colonies growing

at 20° and at 37° and in lactose broth in fermentation tubes for detecting the colon bacillus which is taken as an index of fecal contamination.

The organisms growing at 20° do not include intestinal bacteria and are nonpathogenic, but their numbers offer some evidence as to the organic matter present. The count at 37° includes the intestinal forms although it does not exclude certain others, and offers no distinction between organisms from human beings and those from the lower animals. For these reasons all results on miscellaneous samples must be considered in conjunction with the sanitary inspection of the sources before deciding as to the possibility of danger. The bacteriological examination is the only satisfactory device for the control of filtration plant operation. It also offers the best check on the efficiency of chlorination or other process of disinfection. It is recognized that the B. coli group includes all nonspore-forming bacilli which ferment lactose with gas formation and grow aerobically on standard solid media. In many routine laboratories reports are made on the counts at 20° and at 37°, with fermentation results in 0.01 c.c., 0.1 c.c., 1 c.c., 10 c.c., 20 c.c., 30 c.c., 40 c.c., and 50 c.c. quantities. The first two of these fermentations are made on dilutions of the original sample and the latter are arrived at by incubating five fermentation tubes, each containing 10 c.c. of sample. This so-called presumptive test is conclusive if negative. If positive, it may be confirmed by more elaborate procedures, employing plate cultures on Endo's medium or on litmus-lactose-agar. The "confirmed" and "completed" tests of the official methods are designed to distinguish B. coli from certain spore-forming bacilli which also ferment lactose. The differentiation between fecal and nonfecal members of the B. coli group is a matter of considerable technical difficulty. Table L shows some typical routine results.

Sample No. 1 is typical of a great many waters from agricultural districts. There are many organisms present, including the colon bacillus. The chloride is about five times higher than the normal for that district. The pollution in this instance comes from stables and barnyards. While this is not a wholesome water, especially for children, it does not give rise to specific diseases such as typhoid fever. People become accustomed to such waters but such a supply

TABLE L

SAMPLE NO.	SOURCE	COUNT ON GELATINE AT 20°	COUNT ON AGAR AT 37°	FERMENTATION TESTS FOR B. COLI								CHLORINE AS CHLORIDE
				0.01	0.1	1 c.c.	10 c.c.	20	30	40	50	
1	Shallow well farm barn yard	120	600	−	+	+	+	+	+	+	+	75
2	Shallow well farm house	100	350	−	+	+	+	+	+	+	+	60
3	Spring I	400	200	−	−	−	−	−	−	−	+	20
4	Spring II	200	100	−	−	−	−	−	−	−	−	80
5	Lake	100	5	−	−	−	−	−	−	−	−	12
6	River Water at Intake	500	150	+	+	+	+	+	+	+	+	15
7	River Water Chlorinated	200	10	−	−	−	+	+	+	+	+	16
8	Lake B at Intake	1200	400	−	+	+	+	+	+	+	+	10
9	After Filtration Bed No. 1.	100	10	−	−	−	−	−	−	−	+	10
10	After Filtration Bed No. 1.	1000	400	−	−	+	+	+	+	+	+	10
11	Combined Effluent Chlorinated	400	1	−	−	−	−	−	−	−	−	11
12	Drilled Well	100	0	−	−	−	−	−	−	−	−	1,850

may have more bearing upon general health than is commonly accepted.

Sample No. 2—from the same farm as No. 1—is also contaminated. This is worse than No. 1 because the colon bacillus is more likely to be from intestinal discharges of human beings as the privy vaults are nearby. There has been no history of typhoid in this house, showing that the pathogenic organisms do not originate in fecal matter. If any one who was discharging typhoid bacilli during an ambulatory attack, or possibly years after recovery from the disease, made use of the privy the well water might easily become a source of danger. Consumers have escaped only because of the absence of infection.

Sample No. 3 from a spring shows a large number of organisms. The colon bacillus is present in only one of the five 10 c.c. tubes. This indicates a small amount of contamination, not ordinarily considered dangerous. It comes within the standard specified for interstate carriers. One must depend upon the sanitary inspection of the surroundings to decide as to the possibility of the contamination being greater and more dangerous at times.

Sample No. 4—from the same locality as No. 3. The bacteriological findings are negative. The chloride is much above normal, indicating that possibly there is a natural filter operating. Sanitary inspection in this case showed that the chloride came from an ice cream freezer and was, therefore, without sanitary significance.

Sample No. 5—from a lake—shows satisfactory quality but it is unwise to assume that the whole lake is like this, or that contamination might not be intermittent at the sampling point.

Sample No. 6—a dirty water—consumers of it might expect trouble at any time.

Sample No. 7—chlorination not successful. The mechanical details should be investigated; possibly the dosage should be increased. There is probably a false sense of security here.

Sample No. 8—a grossly polluted water.

Sample No. 9 represents No. 8 after being filtered—the danger has been in greater part removed.

Sample No. 10—a dirty filter. The dirty filtered water is sometimes worse than the raw water if filter is not operated properly.

Sample No. 11—chlorination is apparently effective—a safeguard,

even to filtered waters. The only way to control these processes is by bacteriological examinations.

Sample No. 12 is an example of highly saline water as shown by the chloride content. The chloride in this case is of mineral origin and consists mainly of calcium chloride with a lesser amount of sodium chloride. Unfortunately there is no established method for the satisfactory treatment of such waters.

The nearest approach we have to a satisfactory bacterial standard for drinking water is that determined by the U. S. Treasury Department for interstate carriers such as trains. According to this standard, if five 10 c.c. portions of the water are incubated with the proper media,[2] not more than one of them should show effects indicative of the colon bacillus. Recent experiences[14] at Cleveland and elsewhere have shown that the fermentation tube warnings of possible danger should not be disregarded.

WATER PURIFICATION

A stream may be polluted with sewage and still provide a water supply for a municipality if purification processes are applied. Although certain natural forces are at work, and it is a very old saying that "running water purifies itself," some of the greatest tragedies in the history of water-borne diseases have arisen from too great dependence upon this natural purification which is often very uncertain. As it flows, the river water may be diluted with water of better quality from rain or from tributary streams and springs. There is aeration at falls and rapids and this tends to maintenance of the aerobic forms of bacterial life which oxidize organic matter by the process already referred to as "nitrification." Algae and other plants draw upon the organic matter of the water for part of their food supply. This latter action is reversed if masses of plant growth accumulate and decompose. The simpler forms of animal life such as lower Crustaceans and Infusoria feed upon bacteria and other organic matter. Sunlight has a bactericidal action. Sedimentation may take place especially in deep sluggish portions of the stream, colloids such as silt and clay tending to precipitate organic matter in coagulated form. Bacteria are included in this sediment. A great deal depends upon the char-

acter of the river bed, especially if there are periodic floods. The temperature is unsuitable for the multiplication of pathogenic microorganisms. With all these variables it is impossible to calculate the margin of safety and consequently the purification process has to be controlled by various devices to make the operation more dependable.

STORAGE

Storing in reservoirs for a considerable time may be resorted to under certain conditions. The disease-producing bacteria are out of their natural environment and, gradually becoming attenuated, are destroyed largely from lack of food, the unfavorable temperature, and the action of sunlight. The chemical changes are complex but may be summed up briefly as follows: A temporary increase in free ammonia, which is especially pronounced at depth if there is poor circulation and semianaerobic conditions persist, is followed by increase in nitrites which on longer storage oxidize to nitrates. Nitrates may also decrease at first if certain types of bacteria are present (see nitrogen cycle). Albuminoid ammonia and oxidizable organic matter (shown by the potassium permanganate required to oxidize it) show steady decrease. Color removal depends upon the nature of the color. In some cases a storage period of three months reduces color 60 per cent but twelve months would be necessary to decolorize completely. If the color is due largely to colloidal organic matter, and there is a small amount of iron present, the latter may act as a coagulant and the precipitation of all color may be complete in a few days.

SLOW SAND FILTRATION

The passage of water through specially prepared beds of sand with a view to removal of visible suspended particles, was applied in England as early as 1829. At that time there was no preconceived plan for the removal of bacteria, because the germ theory of disease was not proposed until twenty years later. The efficiency of the slow sand filter from the bacterial standpoint was, however, clearly demonstrated in the historic epidemic of cholera which visited Hamburg in 1892. The people in one district were supplied

with filtered water and those in another district used the same water without filtration. The map showing incidence of cases indicates quite clearly the protection afforded by filtration.

Slow sand filters are something more than mere strainers. It is found that when first used a filter of this kind has little or no efficiency until after a certain "tuning up" period has elapsed. At the end of that time the surface layers are found to be very rich in the simpler forms of plant and animal life. It is to the biological action in this part of the bed that the greatest effect is due.

Suspended solids and apparent color are completely removed. True color is commonly unaffected because the action of the filter is

TABLE LI

TYPICAL AVERAGE ANALYSIS SHOWING CHANGES EFFECTED BY SLOW SAND FILTRATION

	NITROGEN				COLOR	TURBIDITY	CHLORINE AS CHLORIDE
	FREE AMMONIA	ALB. AMMONIA	NITRITES	NITRATES			
Raw Water	0.017	0.096	0.0050	0.61	40	10	12
Filtered Water	0.015	0.054	0.0000	0.67	35	0	12

	Bacteria per c.c.	B. coli
Raw Water	1460	+ 1 c.c.
Filtered Water	16	– 50 c.c.

essentially an oxidizing one and vegetable matter in solution is only rarely oxidized without difficulty. Bacterial efficiency is high, as ordinarily the filtered water does not show the presence of B. coli in more than 1 per cent of 1 c.c. fermentation tests, although the raw water shows it in 100 per cent of such tests. The slow sand filter is expensive to install but its operating costs are low, and, being suitable for colorless waters with low turbidity, it is often cheaper than other methods if there is no difficulty in securing a sufficient area of land. The latter is often an obstacle, as an acre must be provided for each two to five million gallons required per day. The upper layer of sand is liable to become overcharged with finely divided solids from the water and to become very dirty. It

is then necessary to remove this sand which may be washed and replaced.

MECHANICAL FILTRATION

For highly colored and turbid waters it is usually more satisfactory to use a coagulant and to filter rapidly through sand either by gravity or by means of some form of mechanical filter. The most common coagulant is the so-called "filter alum" (although ferric sulphate and ferrous sulphate have been used) with or without lime, depending upon the character of the water.

Filter alum is not one of the true alums. The latter are double sulphates represented by the general formula $R_2M_2\ (SO_4)_4.24H_2O$ where $R = Fe$, Al, Cr, or Mn, and $M = Na$, K or NH_4. They are all isomorphous and crystallize in the cubic system. The most common alum is the aluminium ammonium sulphate, $Al_2(NH_4)_2(SO_4)_4.24H_2O$. Filter alum is a commercial aluminium sulphate, $Al_2(SO_4)_3$, made from the mineral oxide (Bauxite) by treatment with sulphuric acid. It usually contains small amounts of iron and other impurities. When added to a water containing calcium bicarbonate the following chemical change takes place:

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 + 3H_2O \rightarrow 2Al(OH)_3 + 3CaSO_4 + 6CO_2.$$

The aluminium hydroxide appears as a white gelatinous precipitate and is most effective in minute particles not much larger than pin points. It is necessary that the water contain this bicarbonate or other form of alkalinity and if not present it must be added either in the form of lime or of soda ash (Na_2CO_3). The formation of the precipitate is in all probability dependent upon hydrogen-ion concentration. With distilled water sulphate of aluminium reacts acid to litmus, the sulphuric acid being liberated by hydrolysis—since aluminium is a weak base.

$$Al_2(SO_4)_3 + 3H_2O \rightleftarrows 2Al(OH)_3 + 3H_2SO_4$$

When lime or other alkali neutralizes the sulphuric acid, this chemical equilibrium is disturbed, the saturation point of the aluminium hydroxide is soon exceeded and it appears as a precipitate.

With ferric sulphate the reactions are similar:

$$Fe_2(SO_4)_3 + 6H_2O \rightleftharpoons 2Fe(OH)_3 + 3H_2SO_4$$

Ferric sulphate in aqueous solution reacts acid to litmus. When added to a water containing alkalinity either as calcium bicarbonate, carbonate or as added soda ash, ferric hydroxide appears as a red-brown precipitate with properties generally similar to those of the aluminium hydroxide. Ferric sulphate has the disadvantage of being objectionable in case of overdosage, and also is quite inapplicable to many highly colored waters because of the very dark-colored products formed by iron with vegetable matter containing tannic acid and related compounds. The action in removal of color and turbidity is based entirely on the principles of the physics and chemistry of colloids. Anyone interested in the details of this process should develop the subject from this standpoint, with special elaboration of the following features which are fundamental:

SOME NOTES ON THE COAGULATION OF COLLOIDS

The particles in colloidal suspension, colloidal solution and true or molecular solution are approximately of the following sizes (diameters): Coarse suspensions, greater than 0.1 micron; colloidal solutions, between 0.1 micron and 1.0 millimicron; molecular solutions, less than 1.0 millimicron (one micron $= 10^{-3}$ mm.; one millimicron $= 10^{-6}$ mm.).

The coagulation of colloids is of electrical nature. When a colloidal solution is electrolyzed the particles may migrate to the cathode (cationic colloid) or to the anode (anionic colloid). This behavior in an electric field suggests that the particles of cationic colloids bear positive charges and that particles of anionic colloids are charged negatively. When these charges are neutralized there is coagulation of the particles. This may be effected by the addition of electrolytes. Saline solutions precipitate colloidal solutions and suspensions of material such as clay and silica. It is the operation of this factor which produces sand bars at the outlets of rivers where a turbid water with low saline content meets salt water. The effect is greater when the electrolyte is added suddenly.

The charges on the particles may also be neutralized by adding a colloid of the opposite type (anionic colloids precipitated by cationic, and vice versa).

1°—There is no precipitation if a small amount of colloid of opposite electrical charge is added.

2°—As the quantity of added colloid is increased, coagulative action becomes more and more noticeable until a certain proportion is reached which gives immediate coagulation. At this point the numbers of the particles of each kind are just sufficient to produce uncharged masses which coalesce by surface tension and then tend to settle out.

3°—Increase of the proportion of added colloid causes coagulation to cease. The particles assume the charge of the colloid which is in excess.

4°—There is thus an optimum proportion which must not be deviated from in either way (excess or deficiency) or there is no coagulation.

5°—The above apply to the *sudden* addition of colloid, in which the effect is greater than if addition is gradual.

6°—With the exception of a few compounds of selenium, addition of colloid of the same sign produces no coagulation.

Protective Colloids.—Many organic colloids when added in comparatively minute quantities have the power of preventing the coagulation of particles in colloidal solution or suspension. Apparently the particles become coated with thin films which either prevent the neutralization of the charges on the particles or interfere mechanically with the coalescence of the particles after the charges are neutralized. Many colloidal solutions owe their permanence to some protecting substance present in small amounts.

This fact appears to complicate color removal from some waters. In other cases the color is in true molecular solution and the addition of coagulants is not effective. The principles outlined explain:

1°—Action of $Al(OH)_3$ and $Fe(OH)_3$ in clarification.

2°—Variation in dosage even in water from the same source of supply depending upon variations in color and turbidity.

3°—Some cases in which excess of coagulant appears to make matters worse.

There have been but few studies of the mechanism of the action

by which bacteria are included in the precipitate. Apparently the organisms are not charged, but are entangled in the precipitate. Surface tension plays an important part. Gelatinous films tend to adsorb.

In general, the action of the alum is to throw down a colloidal precipitate which carries with it colloidal matter associated with color and turbidity. Bacteria are included in the precipitate and collected with it. A great deal depends upon the size of the particles in the precipitate and upon the time allowed for coagulation. The latter is very short on filters of the drifting sand type. Table LII shows typical analytical results:

TABLE LII

RAPID MECHANICAL FILTER USING COAGULANT

	TURBIDITY	COLOR	NITROGEN AS FREE NH_3	NITROGEN AS ALB. NH_3	MICROSCOPIC ORGANISMS	BACTERIA PER C.C.	B. COLI
Raw Water	35	70	0.031	0.184	73	22500	+ 0.1 c.c.
Filtered Water	0	10	0.018	0.087	0	570	– 50 c.c.

Temporary hardness is decreased but the permanent hardness is slightly increased. Removal of turbidity is complete. If the color is of the type which is difficult to remove, it is usual to make adjustments of alum dosage to keep color below 30. The filtered water is practically saturated with carbon dioxide. The bearing upon corrosion of iron pipes and tanks is not definitely established but it appears to aggravate the process of corrosion when it has once started—especially in heating systems.

It is usually stated that there are no aluminium compounds present in the filtered water. In actual practice there is very frequently a small amount of aluminium present either as excess sulphate from overdosage, or as aluminium hydroxide which has passed the filter in the form of colloidal solution. In either case these compounds are not present in quantities great enough to injure the consumers.

The alum is applied either in solution or in the form of pulverized crystals. The amount required is exceedingly variable, depending upon the quality of the water. There is also a seasonal effect due to temperature changes—the winter requirement being lower than

that of the summer. With the same water supply increase in turbidity necessitates increase in alum dosage. In fact the adjustment of the alum is often very delicate and requires special and continued attention in each individual case, especially if the raw water varies greatly in quality. In many plants it is found advisable, with chlorination as a safeguard, to reduce the dosage of alum to the smallest limit consistent with removal of turbidity, the greater part or all of the color, 90 or 95 per cent of bacteria, and not to operate the filter itself at maximum efficiency as far as bacterial removal is concerned, thereby effecting considerable economy.

Removal of precipitated aluminium hydroxide with adsorbed and included impurities from the water may be effected in a variety of ways. Some types of filters require frequent "back washing" for cleaning. In others such as the "drifting sand filter," the removal of this sand and its replacement is more or less continuous. The design and operation of all such filters is largely an engineering problem. Much work has yet to be done in comparing different systems with regard to costs of construction, operation and maintenance required in each case for efficient and satisfactory purification as controlled by laboratory tests.[15]

DISINFECTION OF WATER

It is noted that even if a filter is removing 95 per cent of the bacteria present in a water, the numbers passing through are very considerable in the case of grossly polluted water. Very often the use of a contaminated water is compulsory under conditions where filtration is impossible—such as obtain in camps. Again it may be shown that the water supply of a town is dangerous, but it requires time and money to construct filters. In these circumstances some means of destroying any pathogenic organisms which may be present is of prime importance—greater than the improvement in the attractiveness of the water.

HEAT

Boiling before use is a temporary expedient. Water may be made safe for drinking purposes by boiling for fifteen minutes previous to use. However it acquires a flat taste from the expulsion of

dissolved gases and must be thoroughly cooled and preferably aerated. The process, while simple, soon becomes irksome in the household, and people generally object to its continuation for any length of time. A weakness is found also in the use of the raw water for washing fruits and vegetables which are consumed in salads or other forms without heating. Theoretically it should be possible to use heat for disinfection on a large scale, by planning to conserve the heat liberated when the water is cooled down again. The practical difficulties are many and as a general rule such apparatus works much too slowly to be satisfactory. Distillation must be resorted to in some instances, especially where highly saline waters are the only ones available. Distilled water is too expensive for the majority of people in a community.

DOMESTIC FILTERS

It might be noted incidentally that domestic water filters are not to be depended upon. Many types are satisfactory if operated according to directions but a dirty filter allows dangerous bacteria to pass through and in fact a water which is contaminated only intermittently will be contaminated continuously by passage through a dirty filter. Various filtering media are used such as cylinders of porcelain or compressed siliceous earth, or natural rock. Bacterial efficiency may be high if they are cleaned properly and sufficiently often. Failure in the human element is so probable that it is much better and ultimately cheaper to install municipal systems and have purification processes carried out at central plants.

CHLORINATION OF WATER

Bleaching powder, or "chloride of lime," technically known as "bleach" is a by-product of the caustic soda industry. In the electrolysis of sodium chloride, sodium hydroxide is formed at the cathode and chlorine is given off at the anode. The chlorine may be liquefied by compression pumps and sold in steel cylinders or drums but by older methods was passed into chambers containing lime and held there combined as calcium chloride and calcium hypochlorite: $2CaO + 2Cl_2 \rightarrow CaCl_2 + Ca(ClO)_2$. It is generally accepted that

the composition of bleaching powder may be represented by the formula $\mathrm{Ca}\begin{matrix}\diagup \mathrm{O{-}Cl}\\ \diagdown \mathrm{Cl}\end{matrix}$. In presence of water it reacts as if it were a mixture of calcium chloride ($CaCl_2$) and calcium hypochlorite, $Ca(ClO)_2$. The latter is the calcium salt of a monobasic acid $HClO$, and is the active constituent of the "bleach."

Commercial bleaching powder contains unaltered lime, siliceous material and water and is usually valued on the basis of the so-called "available chlorine." This constitutes about one-third of the total weight of the very best fresh samples. It deteriorates rapidly in moist air containing carbon dioxide.

$$Ca(ClO)_2 + H_2O + CO_2 \rightarrow CaCO_3 + 2HClO$$

The loss of hypochlorous acid proceeds readily and in the course of a few weeks or months the bleaching powder may have only 2 or 3 per cent available chlorine. This is of great practical importance because on many occasions the use of "spent" bleach has failed to accomplish what would have been easily done with a satisfactory bleaching powder containing 30 per cent of available chlorine. Chemical methods for estimating the available chlorine are comparatively simple, several different procedures being based upon the principle of titrating the iodine liberated from potassium iodide by a known amount of the sample.

It was recognized as early as 1861 that bleaching powder had deodorizing properties and its possible value in sewage disposal was indicated in 1888. But it was not until 1908 that its efficiency as a destroyer of intestinal bacteria was definitely established. In that year some experimental work in connection with the drainage from the Chicago stock yards showed that the effects of comparatively small amounts of bleach were apparently much greater than would be expected from the quantity of chemical added. From that time chlorination has developed enormously and at the present time several hundred cities and towns on this continent are disinfecting their general supplies of water in this way, employing either bleaching powder or liquid chlorine.

In applying the bleaching powder it is necessary to mix it with

a small amount of water first and see that all lumps are broken up. It is not necessary that all be dissolved, but the suspension should be uniform, and contain about ten pounds of bleach in twenty imperial gallons of water. Cement tanks are more durable than wood for this work. It should not be made up long before required, the deterioration being at the rate of about two per cent per day.

Provision should be made for the gradual addition of the bleach to the water as it is pumped, and at least one-half hour should elapse before the water is drawn from the taps for use. The action of the bleaching powder is really an oxidation and free chlorine does not appear. The hypochlorite reacts with carbon dioxide in solution, and hypochlorous acid is liberated.

$$Ca(ClO)_2 + CO_2 + H_2O \rightarrow CaCO_3 + 2HClO$$

The hypochlorous acid decomposes, giving nascent oxygen.

$$2HClO \rightarrow 2HCl + 2O$$

The hydrochloric acid is neutralized by the carbonate and bicarbonate in the water forming calcium chloride, thus increasing the permanent hardness by a small amount.

The oxygen just liberated from chemical combination actively attacks organic matter including bacteria, especially those belonging to the colon group. The selective action against organisms of this type is probably due to the fact that they are out of their natural environment and are gradually becoming attenuated. In an ordinary water containing B. coli a fraction of a part of bleach per million of water gives substantially complete destruction of intestinal bacteria.

The amount to apply must be determined by bacteriological examination of the treated water. It is possible, however, to make a judicious guess at the correct amount, and use it as a preliminary, subject to adjustment later on. The orthotolidin test is of value in routine control after standardization. It is not necessary to dispose of all bacteria present but to aim at disinfection by destroying bacteria of intestinal origin rather than at sterilization by increasing dosage to include removal of other harmless forms, especially spore formers.

As a general rule, disinfection may be expected from the application of 1.5 pounds best chloride of lime per 100,000 Imperial gallons of water. This gives, with 33⅓ per cent bleach, a chlorine dosage of 0.5 parts per million. This may be low in rare cases. Hydrogen sulphide, for instance, reacts with bleaching powder, being oxidized to sulphate; ammonia forms chloramines which have a bactericidal action; some forms of organic matter react with hypochlorous acid producing complex compounds; if the organisms are included in solid matter in suspension it is necessary to increase the dose.

When the "efficiency dose," which may be defined as the smallest amount which will effect destruction of organisms belonging to the colon group, has been determined, that amount should be increased slightly in order to give assurance that the proper effect will be constantly obtained and make the administration of it less exacting. On the other hand, dosage should not be excessive in amount above that required because of the production of unpleasant tastes.

The taste encountered in chlorinated waters may be due to hypochlorous acid. Some individuals appear to be hypersensitive and can taste almost infinitesimal amounts of it in solution. Again, the reaction products formed by the hypochlorous acid with certain forms of organic matter such as tarry products, trade wastes, and oils produced by vegetable life in the water, are often very unpleasant. Even slightly excessive dosage of chlorine interferes with the brewing of tea, destroying the delicacy of its flavor.

In waters containing very little vegetable matter, the "efficiency" dose and the "taste" dose are not greatly different. Filtered water from Lake Ontario can be disinfected with 0.25 parts per million chlorine. The taste dose is decidedly below 0.30 parts per million. In such circumstances the amount to apply is 0.27 p.p.m. This must be increased in order to insure disinfection when the water is very turbid. In fact there is much less damage done by slightly excessive dose than there is by giving a false sense of security when adding too little. There seems to be no proof of the statements that chlorinated water disturbs the action of digestive enzymes or that it produces skin lesions when used for washing or bathing purposes. No toxicologist with a reputation has yet stated that these very small amounts of bleaching powder are in any way poisonous.

This gives us then a method of making a highly contaminated water "safe," even if it is at the sacrifice of attractiveness in a few cases. It is a cheap yet effective process for the use of campers, armies in the field, and for emergencies in towns and cities where there may be delay in constructing filters. It is rather exacting in its administration in clear waters of fair organic purity, requiring constant attention and careful engineering supervision to see that the proper amount of bleach is put in.

LIQUID CHLORINE

In the majority of cases it is preferable to use liquid chlorine instead of bleaching powder. It is less objectionable from the esthetic standpoint. People are inclined to be more tolerant than they are with such a common chemical as chloride of lime. The reactions are essentially the same, the bactericidal effect being due to nascent oxygen.

$$Cl_2 + H_2O \rightarrow HCl + HClO$$

$$HClO \rightarrow HCl + O$$

The hydrochloric acid is neutralized by the alkalinity of the water. The apparatus for controlling the administration of liquid chlorine has been developed to a high degree of efficiency and is available in a variety of dependable forms designed to meet the requirements of various conditions.

Although liquid chlorine has to a great extent replaced bleaching powder for the disinfection of municipal water supplies, largely because of the comparative simplicity of its control, still the chloride of lime may be used in circumstances where liquid chlorine is impossible to obtain. The following directions are suitable for campers and those living in summer resorts where the waters are suspected of being contaminated. Procure a good fresh package of chloride of lime and measure out one level teaspoonful of the powder into a tea cup. Add water and rub with the spoon until all lumps are broken up and the whole makes one cupful. Transfer this to another vessel, add three more cupfuls of water and stir until the mixture is uniform. A teaspoonful of this mixture when added to a two

gallon pail of water is sufficient to supply a dosage of about 0.5 p.p.m. chlorine and will destroy all bacteria of intestinal origin in ten minutes. The remainder of the chloride of lime should be protected from exposure to moist air. The solution soon loses its strength and must be prepared for use every two days if required continuously.

ELECTROLYTIC CHLORINE

As it is a comparatively simple matter to produce chlorine electrolytically by decomposing a brine, there have been many attempts at preparing a chlorinating solution in this way. It is difficult to control fumes, and the solution obtained must be standardized before use in order to make sure of dosage. Even if there is a very cheap source of electricity, costs may be higher because the market chlorine is a by-product of the electrolytic caustic soda industry. There is not likely to be difficulty in securing a supply of liquid chlorine and the economy in making a substitute for it is very doubtful under ordinary conditions at the present time.

CHLORAMINE

When solutions of chlorine or of bleaching powder are added to an aqueous solution of ammonia, substitution products known as "chloramines" are formed.

/H	/H	/H
N—H	N—H	N—Cl
\H	\Cl	\Cl
Ammonia	Chloramine	Dichloramine

These chloramines appear to act as protoplasmic poisons and do not depend upon oxidation to destroy bacteria. The addition of ammonium hydroxide to the hypochlorite solution has been therefore suggested, primarily to lower costs by saving chlorine, and also to lessen the difficulty arising from tastes in case of excess dosage. There are disadvantages in that it brings in another chemical; the solutions are unstable and cannot be stored for long periods; it is more difficult to control than liquid chlorine, increased costs

at this point thus tending to counterbalance the saving of bleach. It has been reported on favorably for the destruction of Crenothrix, but the same results might have been obtained with chlorine alone.

Considerable work has been done in the use of antichlors for the removal of excess chlorine or hypochlorite. Sulphides, sulphites, thiosulphates, permanganates have been tried but have not come into general use because they are only a partial success.

OZONE

Ozone is produced from ordinary oxygen by adding energy to it.

$$3O_2 + 64800 \text{ cal.} = 2O_3$$

When dried oxygen is exposed to the action of silent electric discharges in suitable apparatus, about 7.5 per cent of it may be converted into ozone. This storage of energy apparently gives it great activity. Metallic silver is readily oxidized by exposure to it; many organic coloring matters are bleached; bacteria are destroyed, apparently by oxidation.

Ozone has been used for disinfection of water with various degrees of success. It is not directly applicable to dirty and turbid waters, preliminary filtration being necessary in such cases. For the successful production of ozone in quantity, high voltages are necessary —8000 to 20,000 volts. The air or oxygen must be dried in order to avoid production of oxides of nitrogen. The most satisfactory systems expose the water to the ozone by passing through towers, the water passing in one direction, the ozone in the opposite. Undissolved ozone is returned to the ozonizer. The amount actually used is from 0.5 to 1.0 p.p.m.

Engineering difficulties are encountered in providing a continuous supply of ozone and in exposing the water to its action. In France, plants at Paris and Lille have operated satisfactorily; there are several reported failures and some successful trials on this continent. Since a reported failure at Lindsay, Ontario, in 1912, some progress has been made in removing these difficulties. Public Health Report No. 33 by W. A. Manheimer describes its use in purifying the water of a 60,000 gallon swimming pool. Costs vary with the cost of elec-

tricity, and with direct current are about double those with alternating current under otherwise identical conditions. Sterile water was obtained with 1.0 p.p.m. ozone, and a 99.8 per cent bacterial reduction with 0.5 p.p.m. Removal of tastes, odors and colors have been as a rule disappointing.

This process cannot compete with chlorine so far as costs are concerned. However, it has some advantage in that there are no objectionable by-products of the chemical reactions concerned. With improvement in design and operation of the ozonizing apparatus and in the method of exposing the water to its action, it is not impossible to expect this method to find more use in water purification than at present, especially as a finishing stroke to filtration.

ULTRA VIOLET RAYS

Beyond the violet end of the solar spectrum are invisible rays with very short wave lengths, generally referred to as the ultra violet. These short wave lengths are associated with the destruction of bacteria by optical methods, the exact nature of the bactericidal action not being well understood, although it is known to be greatest with wave lengths less than 0.28 μ. There are comparatively few of such wave lengths in the solar spectrum, and consequently, sunlight has a comparatively feeble action upon bacteria. The effect is much greater with the mercury vapor arc, the light being transmitted through quartz because ordinary glass cuts off the active rays. Using a quartz lamp operating with 66 volts and 3.5 amperes current, various organisms were exposed at a distance of 200 mm. Staphylococcus aureus, typhoid bacillus, colon bacillus and cholera vibrio were destroyed in twenty seconds; anthrax required about twenty-five seconds, tetanus, forty seconds. The effect does not appear to be due to ozone, hydrogen peroxide or nitrites, but to a direct action on the protoplasm of the organism.

This is an ideal method so far as production of tastes and odors is concerned. However, it is interfered with by color and turbidity, and consequently is generally applicable only to filtered waters. The apparatus is frail, gradually deteriorates without visible warning and, consequently, strict control must be maintained by frequent bacteriological examinations of the treated water. For ordi-

nary use it is prohibitive from the standpoint of costs, but has future possibilities if the difficulties referred to can be overcome.

It will be seen from the above that liquid chlorine is the cheapest and most widely used disinfectant for water at the present time—both for emergency use and as a supplement to filtration. With such treatment available there is no excuse for any community suffering repeatedly from water-borne epidemics of typhoid fever.

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CHAPTER XIV

MILK

By H. M. Lancaster, B.A.Sc.

Milk is one of our most important foods. Intended by Nature for the growth of the young, it contains the constituents necessary for the construction and repair of the tissues of the body and for energy production. Milk and its products are extensively used by the majority of persons both young and adult in all the civilized races. On the other hand, it is a *dangerous* food if not properly produced and handled. This is because of properties which render it a medium for the dissemination of pathogenic bacteria. There is no one food which has been the means of causing more diseases than has milk. Tuberculosis, typhoid fever, paratyphoid fever, diphtheria and septic sore throat may be transmitted in this way. While cow's milk may be modified for the human infant by diluting with water, adding sugar and cream, it is by no means a perfect substitute for mother's milk for the child. But unfortunately modern conditions of living tend to render breast feeding a practical impossibility in many cases, so that good cow's milk is a factor in providing nourishment for babies during the first year of life. With its content of carbohydrates, fat, protein, inorganic or mineral constituents and vitamines it is invaluable in development of well-nourished children. Even for adults it possesses many advantages over other foods, largely because of the availability of the several constituents. It is, therefore, important to observe and develop those conditions which render milk a nutritional blessing to mankind and to combat those forces which may cause it to be a source of disease.

The secretion of the mammary gland varies in different types of mammals and also in different individuals of the same variety of the species. It is, therefore, very difficult to establish any fixed standard composition for the milk of the human mother or of the cow. Some of the complexities are indicated in Table LIII.

Other constituents which may be present in milk, as drawn from the udder:

TABLE LIII

COMPOSITION OF COW'S MILK (ANALYSIS BY BABCOCK)

Fat = 3.6		Olein		Glycerids of insoluble and nonvolatile acids	3.3	Fat = 3.6	Total Solids=12.7
		Palmitin					
		Stearin					
		Myristicin					
		Butin, trace					
		Caprylin, trace		Glycerids of soluble and volatile acids	0.3		
		Caproin					
		Caprinin, trace					
		Butyrin			3.6		
Nitrogenous Solids		Casein	3.60	Nitrogenous	3.8	Solids not fat= 9.1	
		Albumin	0.60				
		Globulin					
		Galactin	0.20				
		Fibrin					
			3.80				
Non-nitrogenous Solids		Lactose			4.5		
		Citric acid			0.1		
Inorganic or Mineral Constituents		Pot. oxide	0.175	Ash	0.7		
		Sod. oxide	0.070				
		Ca oxide	0.140				
		Mg oxide	0.017				
		Fe oxide	0.001				
Plasma =	96.4	SO_3 (sulphate)	0.027				
	100.0	P_2O_5 (phosphate)	0.170			12.7	
		Cl	0.100				
			0.700				
Water							87.3
							100.00

Dissolved gases—carbon dioxide, nitrogen, oxygen.
Other constituents not estimated by weight.

1. Enzymes: Proteolytic; Carbohydrate—Splitting; Oxidizing; Reducing
2. Vitamines: Fat Soluble A; Water Soluble B; Water Soluble C
3. Cells

1. Antibodies.
2. Excretory substances—saline material such as sodium sulphate—flavoring matter from food.

Additional constituents which may be, and frequently are, present in cow's milk as shipped to distributing centers:

1. Extraneous matter—gross dirt, manure, urine, hair, dust particles.
2. Bacteria—harmless forms, dangerous forms.

VITAMINES

Recent developments in the science of nutrition point to the importance of vitamines. A complex literature on this topic is rapidly accumulating.[19, 20] Milk is one of our very best sources of vitamines. All three forms—fat soluble (A), water soluble (B), and water soluble (C)—are present in fresh milk. In the present state of knowledge it is not possible to estimate them quantitatively, but it appears that the vitamine content of the cow's food is to a great extent concentrated in the milk. We should be compelled to eat several pounds of fresh vegetables to obtain as much vitamine effect as can be obtained from a pint of milk.

ENZYMES

The several enzymes normally present in milk (galactase, lactokinase, lipase, calalase, peroxidases[2, 21]) are partly from the secreted fluid itself and partly from bacteria. They are destroyed by heat, and in fact the absence of enzymes may be taken as an indication that milk has been heated. It is believed that they are of value in assisting digestion.

CELLS

All milk normally contains large numbers of leucocytes and degenerated epithelial cells. Pus cells are an indication of an inflammatory condition if the leucocyte count is high (500,000 or more per c.c.), especially if streptococci are present.

In comparing the milk of the human mother with that of the cow, the following differences are noted:

TABLE LIV

COMPOSITION OF MILK OF VARIOUS MAMMALS (RICHMOND AND KÖNIG)

ANIMAL	SPECIFIC GRAVITY	% TOTAL SOLIDS	% FAT	% PROTEIN	% ASH	% LACTOSE	FUEL VALUE CALORIES	REMARKS
							Per lb.	
Woman (average 94 analyses)	1.0313	11.80	3.30	1.50	0.20	6.80	295	Protein is largely albumin
Cow (average 800 analyses)	1.0315	12.73	3.64	3.55	0.71	4.88	310	Very little albumin—more casein
Goat (average 200 analyses)	1.0305	14.29	4.78	4.29	0.76	4.46	364	
Ewe (average 32 analyses)	1.0341	19.18	6.86	6.52	0.89	4.91	502	

Human milk contains a red pigment and is always thin and watery looking. Cow's milk contains a yellow pigment (lactochrome, containing carotin and xanthophyl), and is more opaque than human milk. The ash content of human milk is lower than that of the cow's milk since it provides for the less rapid growth of a smaller animal; in human milk sodium and potassium compounds are higher in proportion to the calcium. The casein or curd producing constituent is lower in human milk, but the sugar content is higher. The calorific values of the two milks are approximately the same. As referred to elsewhere, cow's milk is not a perfect substitute for the natural food provided for the human infant. Complexities generally arise when the milk of one species is used to feed the young of another species. Guinea pigs will not thrive or indeed survive if fed solely on cow's milk.

On this continent the dairy cow is the animal depended upon for commercial milk supplies. She is different in many ways from the typical beef or range animal, and for the best results requires careful handling, comfortable and sanitary stabling, good food, good water, and good treatment. Milk as referred to in the remainder of this chapter is cow's milk.

COLOSTRUM

Colostrum is the secretion of the mammary gland preceding and following parturition. It is more yellow than milk, has a strong odor, is somewhat mucilaginous and is characterized by the presence of large numbers of leucocytes, lymphocytes, and little understood bodies known as "colostrum corpuscles" which appear to be in some way associated with the secretion of milk. Colostrum is used as food in some countries but is ordinarily legislated against. In the United States, it is unlawful to sell the milk obtained within fifteen days before calving and for at least five days after calving. In Canada the time limits are two weeks before and one week after calving. It usually requires from five to eight days for the secretion of the glands to become normal milk. The change, which is gradual, is indicated by Table LV giving two analyses separated by an interval of seventy-two hours.

Table LV is interesting from the academic standpoint and is of special value in studying the physiological processes of milk production. The nutritional value of milk (so far as carbohydrates,

TABLE LV

COLOSTRUM

	1	2
Specific gravity	1.068	1.035
Fat	3.54	4.08
Casein	2.65	3.33
Albumin	16.56	1.03
Lactose	3.0	4.10
Ash	1.18	0.82
Total solids	26.93	13.56

fats, proteins and mineral constituents are concerned) is shown approximately by an abbreviated analysis, thus:

	Per Cent
Total Solids	12.7
Fat	3.6
Protein	3.8
Ash	0.7
Lactose	4.7
Solids not Fat	9.0

In fact, for chemical standards (legislative) it has been found sufficient to specify minimum permissible content of fat, and of solids other than fat, supplementing this, of course, with necessary provisions to secure cleanliness and freedom from pathogenic bacteria. While the last mentioned feature is the most important from the public health standpoint, it is reasonable to insist upon the food value standard because of the ease with which milk may be diluted with water or be skimmed. The great obstacle in establishing a universal standard is the wide variation in the composition of cow's milk as shown in Table LVI.

Considering all these factors, it is not surprising that there is some difficulty in establishing standards for the fat and solids in milk. The State of Massachusetts was the first on this continent to establish such standards. At one time in that State the standard was seasonal, being lower for the summer than the winter months. At present it is uniform throughout the year, and requires a minimum fat content of 3.35 per cent and a total solids of 12.15 per cent. For many years the United States federal standard was 3.25 per cent fat, 8.50 per cent solids not fat. In September, 1920, the Official Agricultural Chemists agreed that a general standard for the whole

TABLE LVI

VARIATIONS IN THE FAT AND IN SOLIDS NOT FAT IN MILK (COMPILED FROM VARIOUS AUTHORITIES)

VARIABLE	DETAILS OF SAMPLES	% FAT	% SOLIDS NOT FAT	REMARKS
Different portions of the same milking from the same animal A Jersey	"Fore" milk (first portion drawn)	1.59	8.87	In sampling the milk of an individual cow it is important to have the *whole milking* thoroughly mixed. Apparently the fat is partially separated in the udder by physical forces.
	Strippings....................	5.92	8.64	
	Average of whole milking....	4.50	8.65	
Time of milking	Morning milking..............	3.56	8.91	Evening milk slightly richer than the morning.
	Evening milking..............	3.93	8.90	
Season of year and period of lactation	8 cows, January			In summer, diet, exercise, and other conditions are altered. Milk tests lower in summer than in the winter months.
	Jan.-April (average)	3.81	8.62	
	May-August	3.69	8.29	
	Sept.-Nov.	3.92	8.62	
	7 cows, average tests,			Fat and solids both become lower as lactation advances. Season and stage of lactation must be considered together.
	1st 10 days after freshening	3.70	8.79	
	2nd " " " "	3.69	8.67	
	3rd " " " "	3.46	8.56	
Number of lactations	Cow A			Other conditions being the same, a cow usually gives richer milk in her earlier years.
	First lactation	4.46	8.93	
	Second "	4.39	8.88	
	Third "	4.22	8.85	
Breed of animal	Typical Jersey Herd	5.40	9.10	The Holstein gives a much larger quantity of milk, but it is lower in fats and solids.
	" Ayrshire Herd	4.00	8.57	
	" Holstein Herd	3.35	8.65	
Strains in same breed	Holstein A....................	2.9	7.8	A is from a poor strain as far as richness of milk is concerned.
	" B....................	3.86	8.83	B is from a good dairy strain which the dairy farmer should foster. There is greater variation in the milk of Jerseys than in that from any other breed.
	Jersey C....................	4.25	8.52	
	" D....................	6.49	9.56	

Other less important variables are the condition of the cow at calving time, the exposure to extremes of temperature, the balancing of her rations, general treatment and care in handling.

country was impracticable because of the widely variant conditions existing. The association recommended also that it be left to state and municipal authorities to adopt as high standards as their local production conditions may warrant. No doubt the suggestion will be acted upon, although in 1918 it was stated that seven States in the Union had no standards for milk and in the remaining forty-one there were twenty-one different standards.[9] In Canada there is a federal standard which the provinces must support as a minimum, requiring at least 3.25 per cent fat and 8.5 per cent solids not fat. In Ontario the standard is the same as the federal. This certainly represents a sufficiently low nutrient value. Some herds have difficulty in maintaining the 8.5 per cent solids not fat in the summer months; some strains of Holsteins fail to reach this standard. Such substandard milk, if otherwise of good quality, may be sold in Canada if labelled as such and if the percentages of fat and of solids not fat are stated on the container so that the purchaser is aware of what he is getting. In the interests of good dairying, strains should be developed and selected to eliminate those of poor quality. The standard should be kept locally at the highest possible level in order to meet the objection that dairy companies will standardize their product and uniformly supply the consumers with milk slightly over the prescribed line.

FAT IN MILK

The most valuable constituent of milk from the food standpoint is the fat. Chemically it is complex, consisting of glycerides of several organic acids. It is present in the form of globules of different sizes, emulsified, the emulsion being more or less stable, depending upon the sizes of the globules, the amount of caseinogen and other factors influencing the viscosity. The globules in Jersey milk are very large, those in Holstein milk are much smaller, more nearly like those in human milk. It is common experience that the fat tends to rise to the surface when milk is allowed to stand in bottles or other vessels. This method of judging the amount of fat is very erratic although it is popularly used in the household in determining the richness of the daily supply.

For the estimation of the amount of fat in a sample of milk there

are various elaborate laboratory methods, but the one most widely used for commercial purposes is the Babcock test, named after its inventor. For details of manipulation, laboratory books[7, 8, 14] must be consulted, but the principles employed will be gathered from the following brief description. Too great emphasis cannot be laid upon the necessity of thorough mixing by pouring or by shaking before sampling or taking a portion of a sample for any tests, whether physical, chemical or biological. A few minutes' standing will give

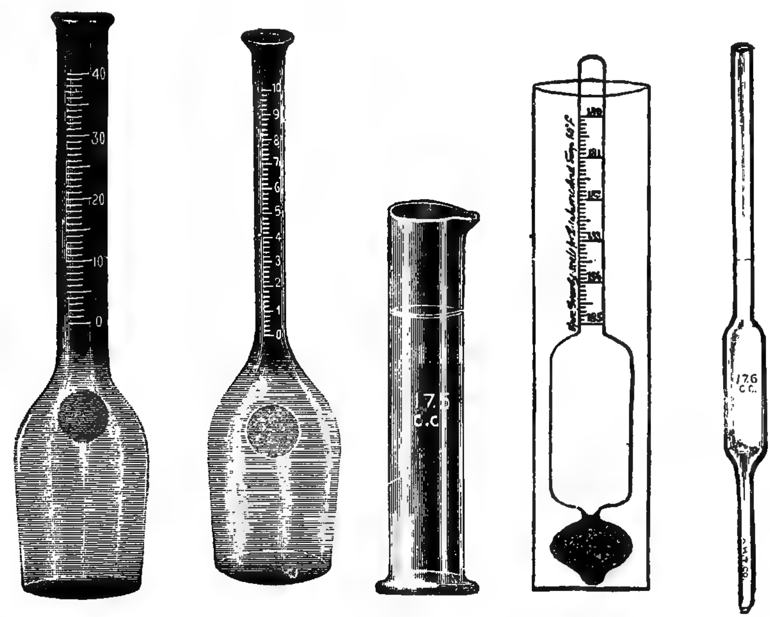
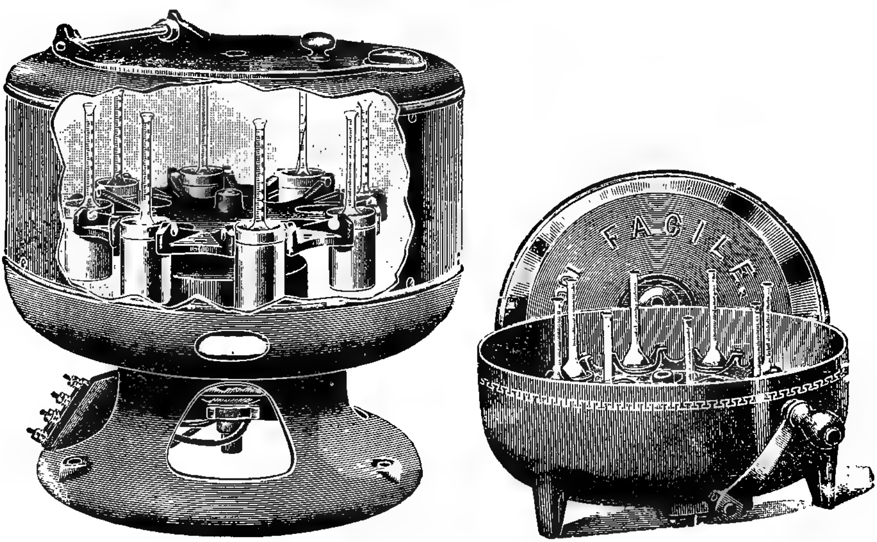


Fig. 46.—Babcock glassware. *A*, cream bottle; the cream must be *weighed* into this bottle. *B*, milk bottle; should bear government mark certifying its accuracy. *C*, cylinder for measuring the acid. Laboratories doing many tests usually have automatic devices. Extreme accuracy is not essential at this point. *D*, a hydrometer for testing the gravity of the acid. If the acid is too concentrated, part of the fat is charred; if the acid is too dilute, the fat is contaminated with curd and readings are not clear. *E*, pipette to deliver 17.6 c.c. (18 grams) of milk. Calibration should be government checked.

an appreciable separation of some constituents. In the Babcock test 17.6 c.c. (the volume of 18 grams of normal milk) is measured from a pipette into a special bottle made for the purpose. This test bottle is so constructed that when the fat is separated and drawn into the neck of the bottle by centrifugal force, the percentage can be read

directly from the graduation marks. In order to separate the fat, sulphuric acid of a certain concentration (sp. gr. 1.82-1.83) is used, 17.5 c.c. of such acid being measured by a cylinder or other device into each bottle in which 17.6 c.c. milk has been placed and the whole mixed by careful manipulation. The immediate effect is a rise in temperature, a charring of the lactose and other solids; the fat is not attacked, but tends to separate as an oily layer on the surface. Separation is hastened by centrifuging, usually for four minutes; hot water is added to raise the fat to the narrow portion of the bottle,



A B

Fig. 47.—Centrifuges for the Babcock test. *A*, electrically driven; *B*, operated by hand power.

and the centrifuging is continued for one minute. More hot water is added to bring the fat within the scale of the bottle, and after being centrifuged again for one minute, the bottle is then placed in hot water (57°-60° C.) and the reading made while the bottle is hot. (Fig. 46.)

In many ways the test is unscientific, but it nevertheless is valuable in that the equipment required is not elaborate or expensive and with attention to a few essential features such as the concentration of the acid one may operate the test satisfactorily without

having had a thorough academic training. In Ontario an act of the legislature legalizes the Babcock test as a means of estimating the fat content of milk and cream purchased on the basis of the fat content. The same act specifies that in testing cream, the sample (18 grams or 9 grams) shall be weighed into the bottle, measurement with a pipette not being satisfactory. (Fig. 47.)

SPECIFIC GRAVITY

A simple instrument called the lactometer or lactodensimeter is used to determine the specific gravity of milk. The density of cow's milk ranges normally from 1.029 to 1.035. In market milk the figures may be as low as 1.014 or as high as 1.042. Skimming tends to raise the specific gravity and dilution with water has the opposite effect. For this reason the lactometer, if used alone, may not be efficient in detecting adulteration. However, it has been noted on many occasions that in towns where the milk supplies have not been systematically checked, the appearance of these simple instruments in the hands of inspectors has a great moral effect upon those who have been tampering with the milk. The instrument, which is a hydrometer or specific gravity spindle, is on the market in a variety of forms, the Quevenne and the New York State Board being the most common. The Quevenne is calibrated with twenty-five divisions in the stem between the limits 1.015 and 1.040. These "degrees" are converted into actual specific gravities by dividing by 1000 and adding 1 to the quotient. (Fig. 48.)

TOTAL SOLIDS

The *total solids* in milk are estimated in the laboratory by weighing the solids obtained as a residue by evaporating a known weight of milk in a previously weighed dish, the evaporation taking place on the water-bath, and the final cooling in a desiccator. Shallow, flat-bottomed dishes of platinum, aluminum, or porcelain may be used. The period of evaporation is usually six hours. This time factor and the necessity of using a chemical balance makes the process a slow and expensive one for laboratories doing a large number of routine analyses. A very close approximation to the truth can be

reached by applying a formula, using the percentage fat (Babcock test) and the specific gravity as determined by the lactometer.

Richmond's formula:

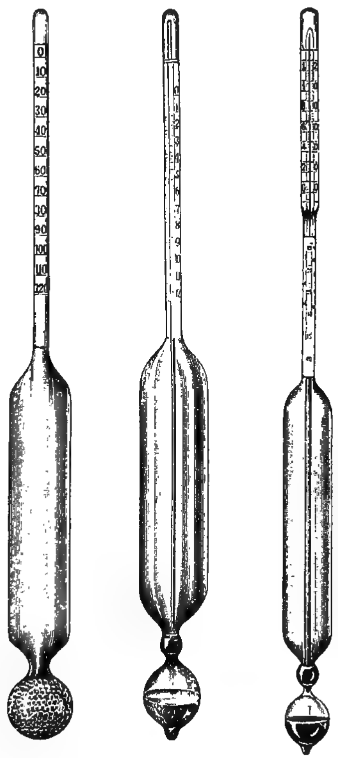
$$T.S. = \frac{G}{4} + 1.27F + 0.14$$

T.S.=% Total Solids, G=1,000 × (Specific Gravity — 1), F=% Fat.

Thus, if Quevenne lactometer reading is 29 and the Babcock test shows 4% fat

$$\text{Total Solids} = \frac{29}{4} + 1.27\text{x}4 + 0.14$$
$$= 12.19\%$$

Calculations may be simplified by using the slide rule constructed for this purpose on the principle of the logarithmic scale.



A *B* *C*

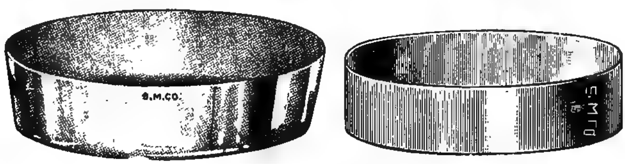
Fig. 48.—Lactometers of different types. *A*, New York Board of Health pattern; *B*, similar to *A* with thermometer included; *C*, the Quevenne lactometer.

A slightly different formula (Babcock's) is commonly used in the United States (Fig 49).

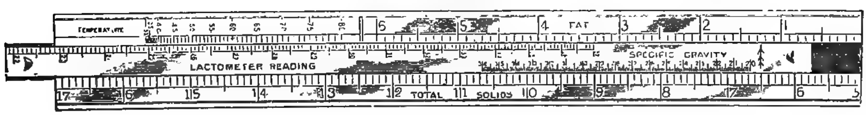
$$\text{Solids not Fat} = \left(\frac{100S\text{—}FS}{100\text{—}1.0753FS}\right) \times (100 - F) \times 2.5$$

S being the specific gravity and F the per cent fat.

By these devices the content of fat and total solids can be determined with very little expense or manipulative skill. Skimming and watering can both be detected in this way. Watering is the more



A *B*



C

Fig. 49.—*A*, platinum dish for evaporating milk for estimating total solids. *B*, a suitable aluminum dish. *C*, Richmond's slide rule to facilitate calculation of the total solids from a formula, making use of the percentage fat (Babcock test) and the specific gravity (from the lactometer reading).

serious of the two evils because of the added danger of infection, especially if the water is not clean and the milk not kept cool subsequently.

SOPHISTICATION OF MILK

The practice of adding thickening agents such as sucrate of lime or gelatine is a deliberate attempt at fraud and should be dealt with as such. Laboratory methods for detecting such additions are well established.[14] Chemical analysis is also a means of detecting the presence of substances such as sugar added to increase the solids not fat after the milk has been watered. (Fig. 50.)

SEDIMENT

Milk as collected at receiving stations in large cities or at the dairies in smaller places contains more or less dirt which comes

chiefly from the body of the cow, stable dust and manure particles. Proper straining removes the greater part of this. Milk collected at a large city dairy very frequently shows visible dirt or sediment on standing. This dirt may not give rise to any specific disease, but is not appetizing, to say the least. It should be shown to the producer that such conditions are not desirable. The best means of beginning this is to collect the sediment in a systematic way. Sediment or dirt testers are now standardized apparatus. A pint or quart of the sample is usually passed through a standard filter disc of cotton.

Fig. 50.—Milk-testing laboratory, Department of Public Health, Toronto.

Two different forms of the testers are shown in Fig. 52. The discs from dirty and from clean milk are also shown. Such discs may be dried and filed for reference, may be used for public display, or they may be returned to the producer with the proper advice. (Figs. 51 and 52.)

This test has also been subject to criticism, the argument being that it is no indication of the *soluble* dirt and only results in obtaining *"cleaned"* milk instead of clean milk, the implication being that straining will be carried out more carefully at the farm. How-

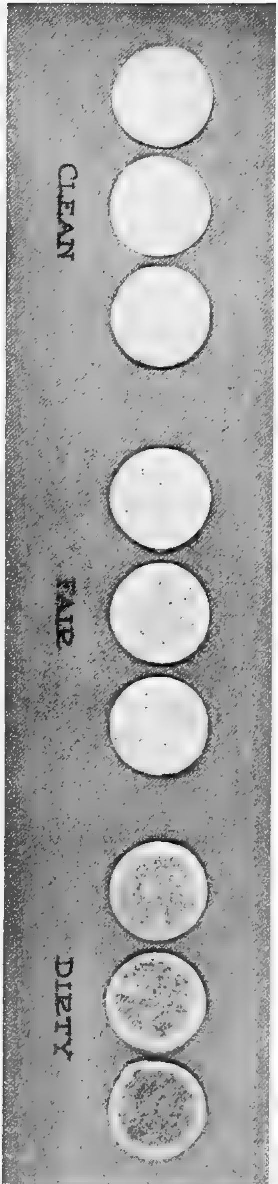
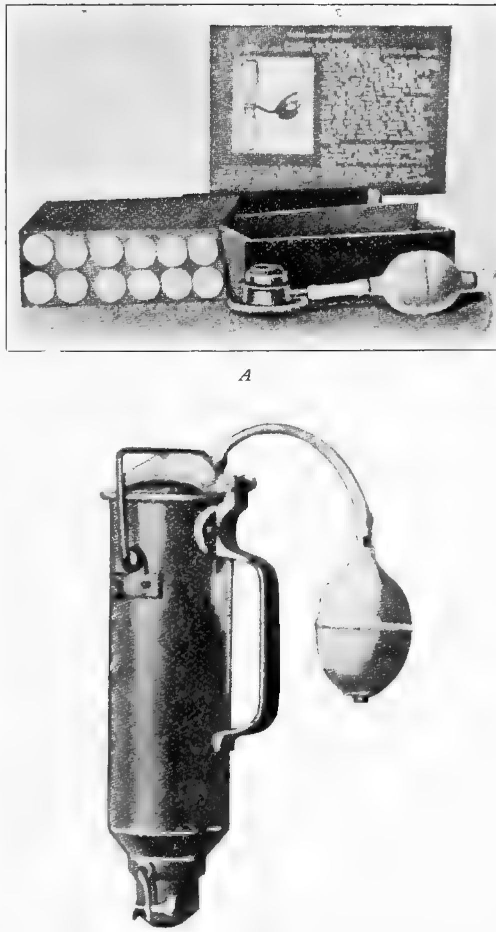


Fig. 51.—Milk sediment discs, Department of Public Health, Toronto.



A

B

Fig. 52. Dirt or sediment testers. *A*, the Wizard. Milk is passed from one bottle to another through standard discs of cotton. *B*, another type. Milk (one pint) is placed in the cylinder and passed through the cotton disc which is inserted in the bottom. The bulb is to hasten the process by increasing the pressure.

ever, when used in the proper way it frequently results in improved conditions. (Fig. 53.)

BACTERIA IN MILK

Examinations of milk drawn from the udder by catheter have in some cases[21] failed to show the presence of bacteria, and the con-

Fig. 53.—Collection of milk samples from delivery wagons. Inspection for visible dirt made at time.

clusion is that such microorganisms are not necessary agents in milk secretion. However, it is generally recognized that the teats and the udder, particularly the lower portion, have a bacterial flora more or less complex and it is not possible to draw sterile milk in quantity, especially under ordinary conditions of milking. Many of the forms present are harmless, and are associated with the souring

process which normally takes place subsequently. The lactic acid bacillus is not the only organism which has this action. A short chain streptococcus, e.g., Streptococcus lacticus, has a similar effect. Organisms (fortunately very rarely occurring in the udder) may be responsible for some abnormalities. Bacillus cyanogenes is a chromogen which produces a blue pigment; Bacillus erythrogenes produces a red pigment; a less common micrococcus produces a bitter flavor in milk. The Bacillus abortus (Bang) responsible for causing contagious abortion in cattle, may be present in the milk of an animal having that disease. The possibility of its giving rise to similar conditions in human beings has not been established. Inflammatory conditions in the udder commonly result in the discharge of bacteria of which the most dangerous to man are streptococci. If the cow has tuberculosis, the milk is quite likely to contain tubercle bacilli of the type causative of the disease, and nearly always does contain the organisms if the udder is tuberculous.

Under ordinary conditions the colon bacillus is always found present in freshly drawn milk, but it no doubt enters by means of manure particles. From the dust of stables other organisms are added. Many of these are not injurious but there are some types that are troublesome. Ropy or slimy milk is caused by a spore forming bacterium and the source of trouble may be found in dust from fodder or bedding, from water used for rinsing or occasionally from an infection in the udders of certain cows. When this organism has once established itself in a dairy, care and patience are required to get rid of it. The best measures to adopt are the following: avoid dust in the stables at milking time; scald all utensils with very hot water; expose pails, strainers, etc., to the action of direct sunlight. If any cow in the herd is so infected, she may be detected by allowing the individual milkings to stand and sour separately. Soapy milk, which froths excessively and gives a cream which will not churn satisfactorily, is less common but is said to be due to bacteria of another type.

Although the streptococci from inflamed udders may give rise to throat infections in the consumer, and bovine tuberculosis may cause tuberculosis of the glandular type, especially in children, and the colon bacillus with its products of growth may be undesirable in the feedings of infants, still the greatest potential danger is the possi-

bility of infection from the persons of those handling the milk. Milkers, dairy workers, and others cannot be too careful in this regard. The organisms causing tuberculosis, sore throat, diphtheria, scarlet fever, diarrhea, typhoid fever may be added in this way. It is always to be remembered that the milk is a good culture medium and that although the organisms added may be comparatively few, multiplication may take place at an enormous rate if the temperature conditions are favorable.

The number of organisms present in milk may vary from a very few to 50,000,000 per c.c. The variable conditions under which the milk is kept are responsible for the wide range of these figures. Where the milk is carefully produced and handled and kept cool until delivered to the consumer within twenty-four hours the count may not exceed 5,000 per c.c.; where milk is seventy-two hours in reaching a center such as a large city, counts below 100,000 are very rare.

While it is possible by the examination of direct smears to estimate very approximately the number of bacteria present and to distinguish between milks which will give high, low, or medium counts, the plating method is much more satisfactory. In this work it is always to be remembered that methods are empirical, no one set of conditions giving all the types present. There is also likely to be considerable clumping of the bacteria, so that a colony developing does not always mean a single organism originally. For these reasons it is better to consider the portion of the flora which from experience has been found most satisfactory, using a standard method. The term "bacteria per c.c." might well be displaced by the designation "plate count." The methods of the American Public Health Association[6] should be followed strictly. (Fig. 54.)

It is not practicable in routine work to isolate pathogenic bacteria from milk. In typhoid fever, for example, the disease may be traced to milk by the characteristics of the outbreak— a short incubation period and the victims being served from one particular milk supply. A chart map showing location of the cases will indicate such possibility. In many instances the disease may be directly traced to recent cases, or it may be necessary to look for carriers (often of over twenty years' standing) by employing the Widal reaction, examination of feces and urines.

The only satisfactory way of examining milk for tubercle bacilli is to make animal inoculations. Guinea pigs may be injected with sediment and cream obtained by centrifuging and examined later for typical lesions. If it is suspected that the cow is tuberculous, the tuberculin test should be applied by a competent veterinarian. Departments of Agriculture supply the necessary material free of charge. This is more satisfactory than looking for the bacilli in the milk, partly because the examination is difficult with so many bacteria present, and partly because the discharge of the organisms may be intermittent. It may be stated here that cows apparently

Fig. 54.—Plating a milk. (U. S. Department of Agriculture, Circ. 53.)

healthy and in excellent flesh as far as fatness is concerned, are sometimes found upon slaughter to contain enormous tuberculous lesions. Although the plate count has been criticized because the large numbers frequently obtained may after all be caused by the multiplication of nonpathogenic forms, it is still one of the best means of indicating the past history of milk.

PRESERVATIVES

There are many chemical compounds such as formaldehyde, borax, boracic acid, salicylic acid which have been used for destroying

bacteria in milk and preventing bacterial growth. Formaldehyde is remarkably efficient. One part of formaldehyde in 50,000 parts of milk prevents souring for several days. While such small amounts may not seriously affect the nutritional value, and may not be injurious to the healthy adult, the effect upon infants and invalids may not always be negligible. The impossibility of controlling the practice if it were permitted is hopeless, and consequently the use of preservatives in milk is prohibited by legislation in most countries of the world. Federal legislation both in Canada and in the United States is very definite on this point. In Canada it is per-

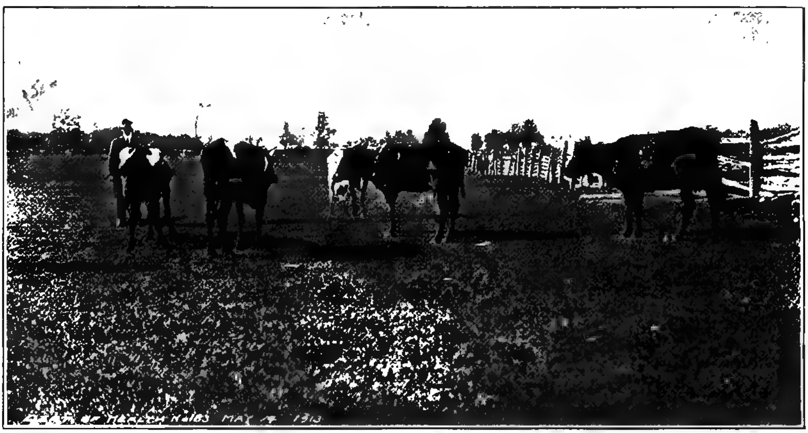


Fig. 55.—All of these cows reacted to tuberculin.

missible to add boric acid to cream, the amount not to exceed one part in four hundred, but the presence of the preservative must be declared.

CONTROL OF BACTERIA

It is possible to control the bacteria in milk by beginning at the source and following persistently all along the way with proper measures. The cow should be nonreactive to the tuberculin test and be free from any diseased condition. There should be no inflammation in the udder or teats; she should have clean flanks, udder and teats, and be milked in a clean stable reasonably free of manure and dust; the milker should be free of any communicable disease; a

Fig. 56.—Tuberculous cow kept in a very bad condition.

Fig. 57.—A satisfactory kind of pail in which to collect milk from the cow. The cover keeps out a great deal of dirt which would fall into the milk if an open pail were used. This is sometimes called the "Denmark" pail. (Bulletin No. 642, U. S. Department of Agriculture.)

small top pail collects less dirt than an ordinary open pail; all utensils should be kept clean and made as nearly sterile as possible by the use of steam or of scalding hot water.[16] The milk should be kept cool, as near 50° F. as possible, and the refrigeration process should be begun as soon after milking as possible. (Figs. 55, 56 and 57.)

If these same principles regarding health of workers, careful handling, sterilization of utensils and refrigeration are followed up through the period of transportation, bottling, and delivery, the consumer will be provided with an excellent food. These are ideal conditions very difficult to maintain, and such milk is very expensive. At ordinary prices, everybody concerned except the consumer would suffer financial loss. A milk of this quality is available in many cities and is sold as "certified" milk—milk certified by medical commissions of local organization who see that the conditions are carried out. Certified milk is defined by the Ontario Milk Act in the following terms:

"It shall be unlawful to apply the term 'certified' to any milk which does not comply with the following standard:

"(a) It shall be taken from cows semi-annually subjected to the tuberculin test and found without reaction;

"(b) It shall contain not more than 10,000 bacteria per cubic centimeter from June to September, both inclusive, and not more than 5,000 bacteria per cubic centimeter from October to May, both inclusive;

"(c) It shall be free from blood, pus, or disease-producing organisms;

"(d) It shall be free from disagreeable odor or taste;

"(e) It shall have undergone no pasteurization or sterilization, and be free from chemical preservatives;

"(f) It shall be cooled to 45° F. or under within half an hour after milking, and kept at that temperature until delivered to the consumer;

"(g) It shall contain twelve to thirteen per cent of milk solids, of which at least three and one-half per cent is butter fat;

"(h) It shall be from a farm the herd of which is inspected monthly by the veterinarian, and the employees of which are examined monthly by a physician;

"Provided that no milk shall be sold as 'certified' until a certificate setting forth that the above conditions have been complied with

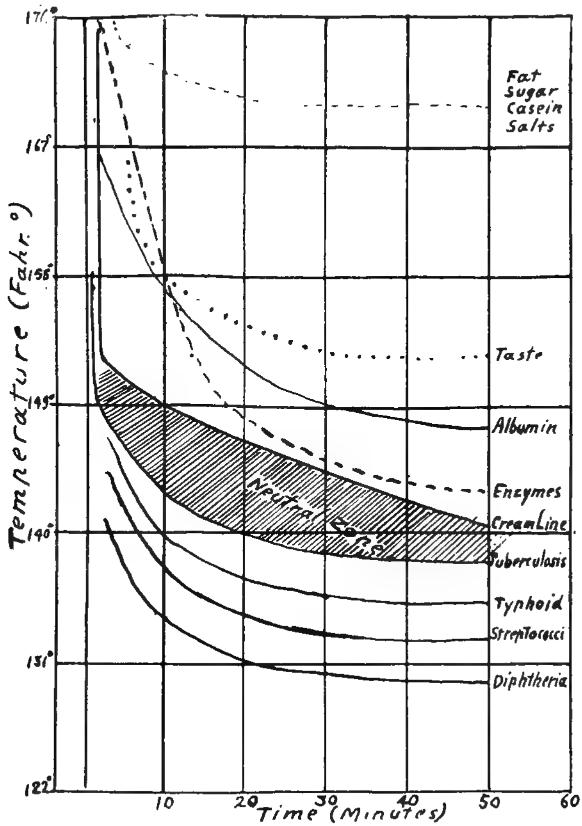


Fig. 58.—Showing the effects produced when milk is heated at different temperatures for various periods of time. (After Dr. North, from Report of Commission on Milk Standards, 1912.)

is obtained from time to time from the Medical Health Officer of the municipality in which it is to be consumed or from an incorporated society of medical practitioners."

Such milk usually sells at about three times the price of ordinary milk and is quite beyond the financial reach of the majority of

people, even for the feeding of very young children. When any one of these controlling factors is dropped there is liable to be a depreciation in quality of the milk,[10] and a dangerous milk results if care is not taken of the more important features regarding health of the animal, health of the workers, cleanliness and proper refrigeration. Since certified milk or milk maintained at that standard is not possible for all, and since there is an element of danger in relaxing the hold upon the controlling details, the condition of affairs would be very bad indeed if it were not for the process of heating which can be readily applied to render a milk *safe* without greatly injuring its nutritional qualities. When a fresh milk is boiled there are many changes effected. Alteration in the proteins is shown especially in the coagulation of the albumin. Calcium and phosphorus are disturbed from organic combination and thrown down as phosphates. Carbon dioxide and other gases are expelled. Partial charring of the lactose causes the development of a brownish color and an altered taste. The arrangement of fat globules is disturbed, the clumps being broken up. When undergoing coagulation with rennin, boiled milk reacts more slowly than the raw or unheated milk, and the curd is more flocculent and softer. Bacteria and enzymes are destroyed. Vitamines are lost, with the possible exception of fat soluble A. Boiled milk is said to be more constipating than is raw milk. This may be due to the destruction of bacteria but more likely to the altered structure of the curd. This process is quite generally practiced in continental Europe. Although such milk is *safe* from the standpoint of communicable diseases, and the vitamine deficiency can be made up by adding them in other foods, the popular objection to boiling the milk is based on the sacrifice of flavor. It has been found, however, that the thermal death point of pathogenic microorganisms in milk is well below the boiling point,[23] and that at moderate temperatures the alterations referred to do not take place. It is noted that the formation of scum on heated milk begins in closed vessels at 60° C. The fat globules are altered and the "cream line" loses its definition if milk is heated for half an hour at 65° C. The cooked taste appears at 70° C; albumin coagulates at 75° C; the rennin coagulation is altered at 80°-90° C. This information is indicated and supplemented very well in the chart prepared by Dr. North (Fig. 58).

PASTEURIZATION

In the so-called "neutral zone" there are time and temperature boundaries which give us the pasteurization limits. There are many definitions of pasteurization,[5] the chief variables being time and temperature. The Ontario Milk Act defines it as follows: "It shall not be lawful to apply the word 'pasteurized' to any milk unless all portions have been subject for at least twenty and not more than thirty minutes to a temperature of not less than 140° and not more than 150° F. and then at once cooled to 45° F. or under and kept at that temperature until delivered to the consumer and the process of pasteurization shall be subject to inspection by the local Medical Officer of Health or such inspector as he may designate; provided always that all such milk shall in all other respects be subject to all the terms and conditions of this act." The last clause is intended to prevent the pasteurization of dirty milk or of milk known to be from diseased cows. Inspection is provided for in order that the process may be carried out properly, as the dairyman cannot always be trusted to do it as defined.

It is necessary to specify a minimum temperature and time in order to make sure that pathogenic bacteria are destroyed. Maximum limits are defined because if overdone there is sacrifice of the cream line (the fat is there but does not rise) so that there is dissatisfaction in the minds of the householders; if heating is very much overdone there is loss of flavor, and the souring process is interfered with.

Extensive observations of infants fed on pasteurized milk show that there is a possibility of scurvy developing in some cases. This is apparently due to a partial destruction of the vitamine referred to as "water soluble C." This is not a reason for serious objection to pasteurization as the deficiency may be met by the addition of orange juice to the pasteurized milk feedings of very young children. Enzymes are not seriously affected if the milk has been properly pasteurized.

Pasteurization is not intended as a means of covering up dirt or as a substitute for all other means of maintaining quality in the milk supply. It is not found in practice to result in carelessness and neglect of all the other principles outlined for the production of

safe and clean milk. One strong argument in favor of pasteurization, even of certified milk, is based on the possibility of virulent forms of streptococci passing without warning from the udder of the cow, or the failure of the milkers to observe the proper precautions regarding their own health, the official monthly inspection being quite insufficient if not supported by a proper spirit in the farm and dairy employees themselves.

Pasteurization of milk may be carried out satisfactorily in the home.[22] With a thermometer at hand, heating may be done in an improvised water-bath using ordinary double boilers. Inexpensive outfits for pasteurizing a number of feedings at one time are on the market. (Fig. 59.)

It is to be noted that pasteurization does not give a *sterile* milk—

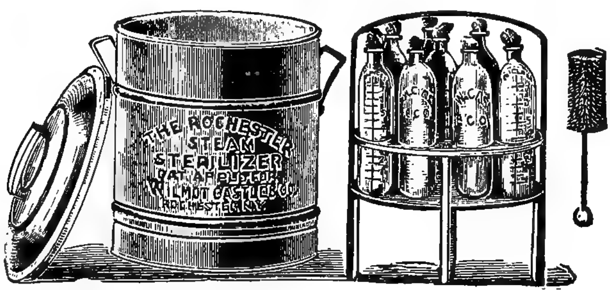


Fig. 59.—A simple home device for pasteurizing milk for infant feeding.

there are bacterial survivors. Of course there are large numbers of bacteria destroyed. Quite commonly the plate count drops from 3,000,000 to 10,000 in the course of the twenty-five minutes' heating. The survivors will carry on the souring process, although many acid formers are destroyed. If milk is pasteurized properly the alterations in the bacterial flora are not a serious detriment.

BACTERIAL STANDARDS

Bacterial standards, while the most logical for controlling the sanitary quality of milk, are by no means universal. The work of Houston and of Savage in England points out the value of such standards, but they have not been established in that country. In Canada federal regulations issued under the Food and Drugs Act

specify that pasteurized milk, when delivered to the consumer, shall not contain more than 100,000 bacteria per cubic centimeter. Table LVII from the records of the Department of Health, Toronto, indicates the necessity of inspection in order that this maximum be not exceeded.

TABLE LVII

INCREASE IN AVERAGE BACTERIA COUNTS IN 6 BOTTLES OF MILK TAKEN FROM POOLED SUPPLY OF 6 CANS PASTEURIZED IN 4 DAIRIES.

	DAIRIES			
	#1	#2	#3	#4
Raw Milk	464,000	900,000	1,400,000	866,000
After Pasteurizing and Cooling	3,000	5,000	15,000	11,600
After Filling Bottles	17,000	7,000	40,000	33,000
On Leaving Dairy on Wagons 1-2 A. M.	14,000	20,000	55,000	61,000
Sampled on Doorstep 4.30-6.00 A. M.	26,000	18,000	43,000	130,000
Sampled on Doorstep 8-9 A. M.	34,000*	40,000	62,000	140,000
Bottles Taken in on Delivery and Placed in Family Icebox	32,000*	36,000	—	142,000

*Average of three (3) bottles.

The Toronto regulations recognize only certified milk and pasteurized milk. As a result of the extensive work carried on by the medical milk commissions of the United States, various bacterial standards for milk have been adopted in a number of states. Apart from "certified milk," which constitutes not more than 1 per cent of the milk of the country, several other grades are permitted. The following is a brief summary of the specifications covering the different grades of milk as defined in regulations which came into force in New York State in November, 1914.

Grade A.—Raw—Must not at any time before delivery to the consumer contain more than 60,000 bacteria per c.c., the cream not more than 300,000 bacteria per c.c., must be delivered within thirty-six hours from the time of milking, must be delivered only in containers sealed at the dairy. The grade and the name and address of the dealer must be on the containers.

Grade A.—Pasteurized—Before pasteurization must not contain more than 200,000 bacteria per c.c. After pasteurization, and before delivery, shall not contain more than 30,000 bacteria per c.c. in the milk and 150,000 per c.c. in the cream. Must be delivered in sealed containers and labelled "Grade A Pasteurized."

Grade B.—Raw—Must not show at any time previous to delivery more than 200,000 bacteria per c.c., and cream not more than 750,000 per c.c. Regulations for delivery same as for Grade A.

Grade B.—Pasteurized—Before pasteurization must not contain more than 300,000 bacteria per c.c. After pasteurization such milk is to be delivered within thirty-six hours and not contain more than 100,000 bacteria per c.c. and such cream delivered within forty-eight hours not more than 500,000 per c.c. Must be labelled "Grade B."

Grade C.—Raw—No bacterial standard; must be delivered within forty-eight hours from time of milking.

Grade C.—Pasteurized—No bacterial standard; to be delivered within forty-eight hours after pasteurization.

For Grade A, cows are to be tested with tuberculin at least once during the preceding year, and the reactors removed from the herd. For Grade B the cows must be healthy as shown by an annual physical examination.

Grade A is suitable for infants and children; Grade B for adults; Grade C is to be used only for cooking and manufacturing purposes.

These standards have been the subject of considerable argument and legal controversy. There are some who say that there are only two kinds of milk, "good" and "bad." For small towns and cities the grading system seems rather complex but it is of value in a large center like New York City where 2,000,000 gallons are used daily nearly all of which comes from places more than fifty miles distant, some of it being brought three hundred miles. One difficulty arises from the necessity of educating the consumer to use the various grades for the purposes for which they are intended—for instance, it is not impossible that grade "C-Raw" might be used for feeding infants, either from misunderstanding or from carelessness. Intestinal disorders and diarrhea might easily result.

From the above outline it will be seen that in order to provide milk of satisfactory quality it is necessary to take precautions all along the way from the time the milk is secreted in the cow until it is placed in the mouth of the consumer. The responsibility rests upon the farmers, the transportation companies, the dairies or distributing agencies, and upon the consumers themselves.

AT THE FARM

It is advisable for the dairy farmer to begin by developing and fostering a good milking strain. Tests on individual cows are the best means of detecting those in the herd that are not profitable.[17] Dairy cows, when milking, should not be fed certain foods such as rape, turnips, corn before it has blossomed, or spoiled ensilage. Even good ensilage should not be given in excessive amounts, especially at first introduction of the ensilage to the rations. Some of these

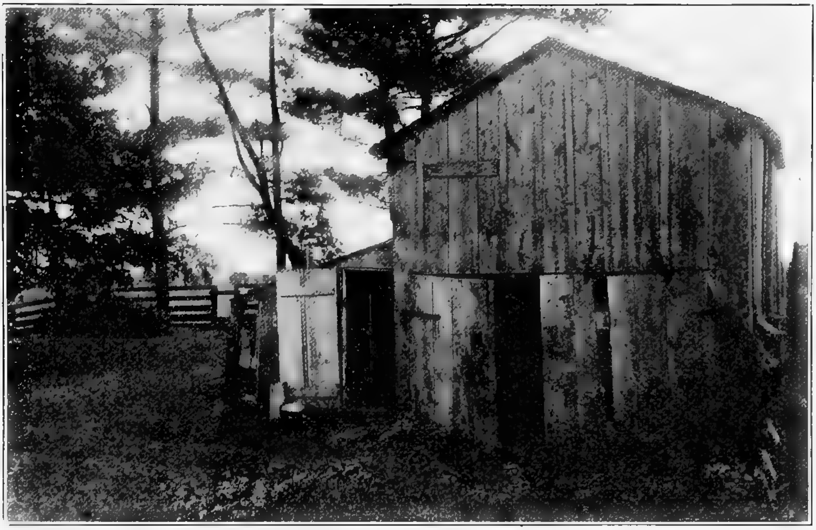


Fig. 60.—Not a good place in which to keep milk.

feeds cause the appearance of objectionable flavors and tastes in the milk. The immature corn will give rise to excretory products which affect the process of digestion in infants. A good water supply is also essential for the dairy farm, since it is used not only for drinking purposes but for washing and cooling. Objectionable bacteria often gain entrance to the milk in this way.

It is possible for the average dairy farmer provided with ordinary equipment to produce clean milk with a low bacterial count. Expensive barns and elaborate stabling are not necessary. The important factors are (1) use of sterilized utensils, (2) cleanliness of cows,

especially as regards flanks, udders and teats, (3) use of small top pail, (4) keeping the milk cool (as near 50° F. as possible).

Dairy herds should be selected from good milking strains and

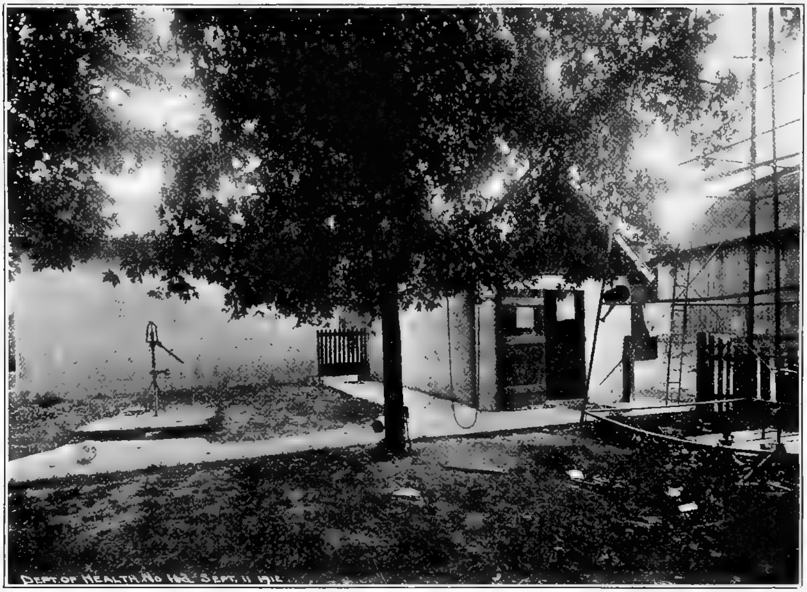


Fig. 61.—Inexpensive but satisfactory milk-house.

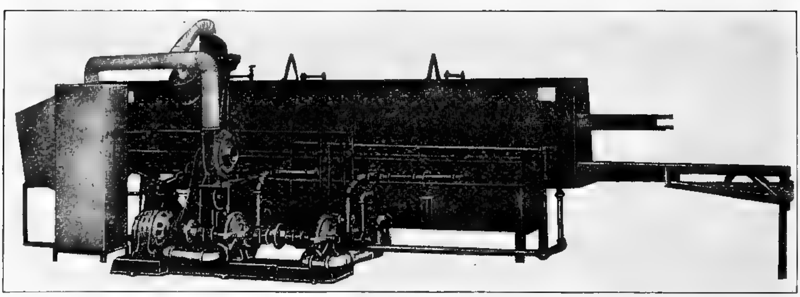


Fig. 62.—Hydraulic can washer. (R. & A.) Drains residual milk, rinses with cold water, washes inside and out with alkaline solution, rinses with boiling hot water under pressure, sterilizes with steam, and dries with blasts of air from a drier.

be tuberculin tested; milk from inflamed udders should not be shipped. The general good health of those handling the milk should be attended to. With these principles in mind the dairy inspector

has ideals with which to influence the producer to improve the quality of his product. With proper men in these positions, a large city can eliminate a great deal of its milk troubles by going to the source. Recent developments have made matters better for the producer. A few years ago there was no reward for cleanliness. The man who sold dirty milk received just as much for it as his more painstaking neighbor did for his. It usually costs more in time and labor to produce clean milk than it does to produce dirty milk. Nowadays milk shipped to cities usually gives a higher return in dollars and cents than that which is sold for butter or cheese making. From the consumer's standpoint, dirty milk is dear at any price. This makes an incentive for the dairy farmer to increase and improve production. The general experience is that when a careless milk producer has been "converted" to better ways, he becomes at once in favor of the higher standards in such matters. Failure to respond to repeated warnings results in the milk from that farm being excluded from the city market.

The judicious use of Producer Score Cards (Fig. 63) is of value to inspectors in systematically checking up the conditions which control the quality of a milk supply. It should always be remembered that they are only a means to an end.

TRANSPORTATION

During transportation from the farm to the dairy, refrigeration is advisable if possible. Long delays should be avoided.

AT THE DAIRY

Milk from the individual cans bearing farmer's name should be examined for sediment—samples taken for determination of fat, total solids, and bacterial count. (Fig. 62.) The larger dairies have their own laboratories and keep records of the milk supplied by each producer. Straining, pasteurization and subsequent cooling should all be carried out with care. Recording thermometers should be used on pasteurizers and on cooling tanks in order to eliminate haphazard guess work. (Figs. 64, 65 and 66.) Machinery should be of the type which can be readily sterilized by steam. Bottles should be cleaned, sterilized and cooled before the milk is placed in them. (Fig. 68.) Machines for filling and capping are a decided advan-

UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY
Dairy Division

SANITARY INSPECTION OF DAIRY FARMS

SCORE CARD

Indorsed by the Official Dairy Instructors' Association.

Owner or lessee of farm____

P. O. address_____________________________ State____________________

Total number of cows____________________ Number milking_______________

Gallons of milk produced daily ______________________________________

Product is sold by producer in families, hotels, restaurants, stores, to ________

______________________________dealer.

For milk supply of ____

Permit No.______________ Date of inspection _____________________, 191___

REMARKS: ____

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*Signed*______________________________

Inspector.

Fig. 63.

Equipment............ + Methods............ = ...Final Score

NOTE 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

NOTE 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

EQUIPMENT	SCORE Perfect	SCORE Allowed.
COWS		
Health	6	....
Apparently in good health 1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed....... 5		
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome)	1	....
Water (clean and fresh)	1	....
STABLES		
Location of stable	2	....
Well drained 1		
Free from contaminating surroundings.... 1		
Construction of stable	4	....
Tight, sound floor and proper gutter....... 2		
Smooth, tight walls and ceiling 1		
Proper stall, tie and manger 1		
Provision for light: Four sq. ft. of glass per cow	4	....
(Three sq. ft., 3, 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		
Bedding	1	....
Ventilation	7	....
Provision for fresh air, controllable flue system 3		
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft..... 3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature.... 1		
UTENSILS		
Construction and condition of utensils	1	....
Water for cleaning	1	....
(Clean, convenient and abundant)		
Small-top milking pail	5	....
Milk cooler	1	....
Clean milking suits	1	....
MILK ROOM OR MILK HOUSE		
Location: Free from contaminating surroundings	1	....
Construction of milk room	2	....
Floor, walls, and ceiling 1		
Light, ventilation, screens 1		
Separate rooms for washing utensils and handling milk	1	....
Facilities for steam	1	....
(Hot water, 0.5.)		
Total	40	....

METHODS	SCORE Perfect	SCORE Allowed.
COWS		
Clean	8	....
(Free from visible dirt, 6.)		
STABLES		
Cleanliness of stables	6	....
Floor 2		
Walls 1		
Ceiling and ledges... 1		
Mangers and partitions 1		
Windows 1		
Stable air at milking time	5	....
Freedom from dust.. 3		
Freedom from odors 2		
Cleanliness of bedding	1	....
Barnyard	2	....
Clean 1		
Well drained........ 1		
Removal of manure daily to 50 feet from stable	2	....
MILK ROOM OR MILK HOUSE		
Cleanliness of milk room	3	....
UTENSILS AND MILKING		
Care and cleanliness of utensils	8	....
Thoroughly washed... 2		
Sterilized in steam for 15 minutes 3		
(Placed over steam jet, or scalded with boiling water, 2.)		
Protected from contamination 3	9	....
Cleanliness of milking		
Clean, dry hands.... 3		
Udders washed and wiped 6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING THE MILK		
Cleanliness of attendants in milk room	2	....
Milk removed immediately from stable without pouring from pail	2	....
Cooled immediately after milking each cow	2	....
Cooled below 50° F.	5	....
(51° to 55°, 4; 56° to 60°, 2.)		....
Stored below 50° F.	3	
(51° to 55°, 2; 56° to 60°, 1.)		
Transportation below 50° F	2	....
(51° to 55°, 1.5; 56° to 60°, 1.)		
(If delivered twice a day, allow perfect score for storage and transportation.)		
Total	60	....

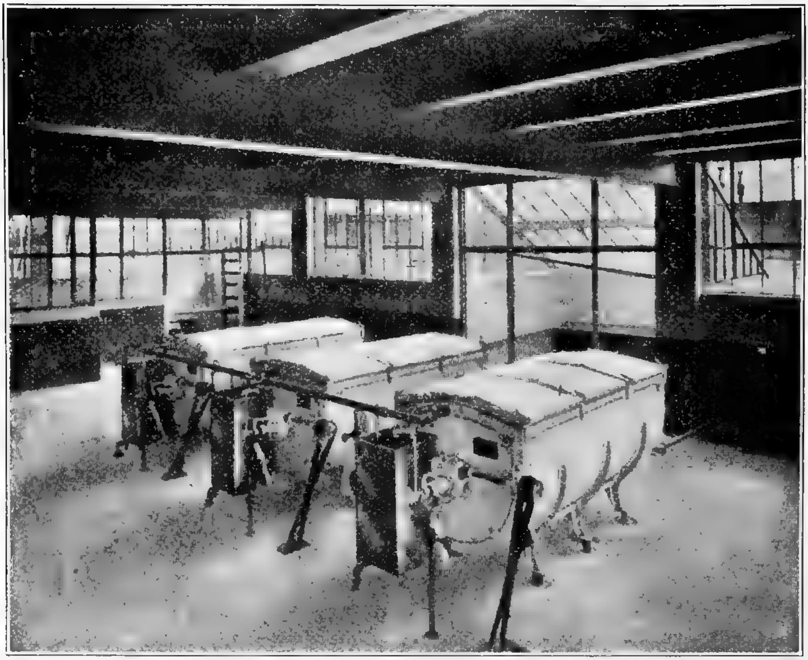

Fig. 64.—Pasteurizers (Cherry type) operated in the plant of the Farmers' Dairy Co., Toronto. Hot water circulates through coils immersed in the tanks. Each vat has a capacity of 500 gallons.

Fig. 65.—Recording thermometer (Taylor Instrument Co.). It may be locked by the Inspector and the discs filed for reference. The best means of checking the operation of the pasteurizers.

tage because less handling is necessary. (Fig. 67.) The milk, when bottled, should be kept cool until delivered to the consumer. Cans for shipment should be cleaned with an alkaline solution, rinsed with

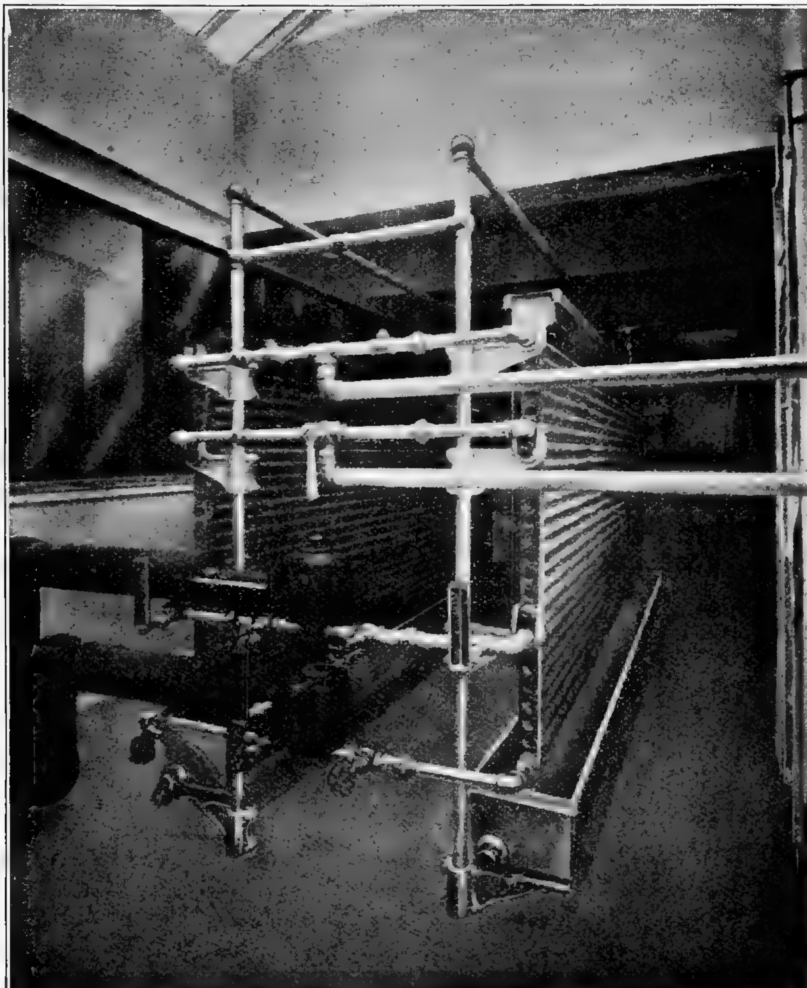

Fig. 66.—Cooling the milk after pasteurizing. Plant of the Farmers' Dairy Co., Toronto.

cold water, then with hot water, steamed and dried before being returned to the producer. All this can be done by automatic machinery—and it is so well done that the cans are ready for receiv-

ing milk again, no cleaning of cans being necessary at the farm. (Fig. 68.) The modern dairies in large cities are, in fact, light, airy buildings equipped with smooth-running, efficient machinery and kept very clean. The dairy score card[11] is of great value in systematic inspection (Fig. 69).

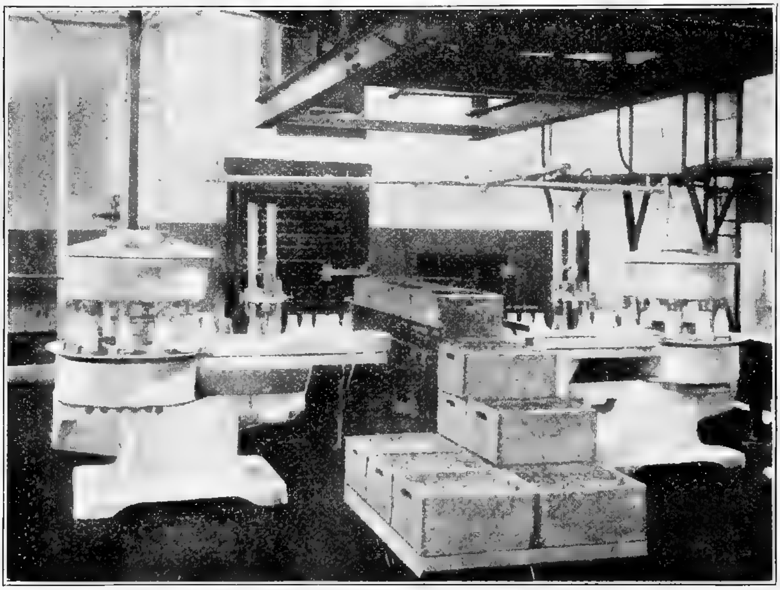

Fig. 67.—Automatic bottle fillers and cappers. (The "Milwaukee", as operated in a Chicago plant.)

CARE OF MILK IN THE HOME

In the home milk should receive the same careful handling as is recommended to the farmer and dairyman.[22] People generally should be informed that although we have friends in the bacterial world we have many enemies therein. Persons affected with communicable disease should not handle milk. The addition of a few organisms would not be so serious if it were not for the multiplication which takes place if the milk is stored under favorable temperature conditions for even a few hours. It is important therefore that the consumer always keep the milk in a cool place until it is required for use.

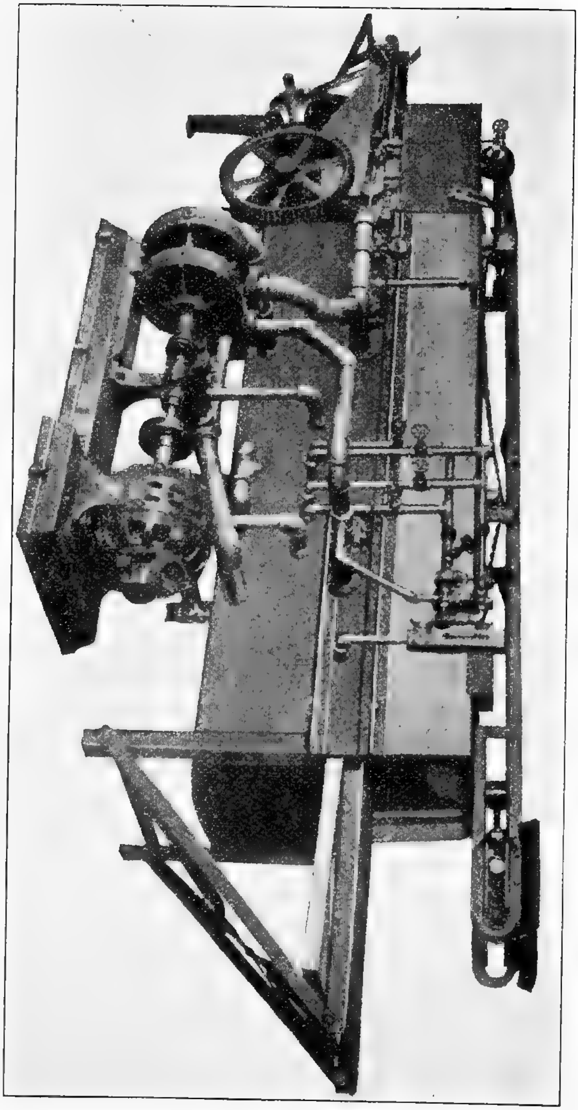

Fig. 68.—Hydraulic bottle washer and sterilizer. (R. & A.) As the bottles pass through they are washed by jets of water of gradually increased temperatures, the final washing being with boiling water. Two men, one to feed in the bottles to the machine, the other to take them out, can with this machine wash and sterilize two thousand bottles per hour.

DEPARTMENT OF PUBLIC HEALTH, TORONTO

DAIRY SCORE CARD

Period..................192....

Dairy............................ *Owner*...........................

Address..........................

Supply—Quarts Milk....................*Cream*...........................

Skim Milk................*Buttermilk*......................

Previous Scores (1)...........*(2)*...........*(3)*...........*(4)*...........

METHODS	Full Score	Given	Date	Official Plate Counts: Milk		Official Plate Counts: Bottles	Official Plate Counts: Cans	Milk Fat
Plant—Cleanliness								
Floors	2							
Walls	2							
Ceilings	1							
Doors	1							
Windows	1							
Good order	1							
Free from odors	1							
Free from flies	4							
Machinery and Utensils Cleanliness—								
Cans properly washed	2							
Bottles properly washed	2							
Cans sealed	2							
Cleanliness of apparatus	12							
Milk Handling								
Use of sediment tester	4							
Pasteurization and cooling	5							
Suits, basins, towels	2							
Storage—45°-50°	8							
Laboratory Findings								
Low retail counts	20							
Sterile bottles	12							
Sterile cans	12							
Quality	6							
Final score	100							

Fig. 69.

EQUIPMENT SCORE

	Full Score	Given
Plant and Location		
Surroundings	5	....
Construction		
Floor and drainage	6	....
Walls and ceiling	4	....
Light and ventilation	5	....
Screens—May-October	5	....
Machinery and Utensils—Quality and Condition		
Bottle washer	5	....
Can washer	5	....
Bottling machine	5	....
Capping machine	5	....
Cold storage	5	....
Pasteurization		
Type of pasteurizer	20	....
Non-exposure to atmosphere..	5	....
Water for Cleaning		
Steam or boiling water	10	....
Attendants		
Clean white suits	5	....
Wash basins provided	5	....
Clean towels provided	5	....
Total	100	....

SUPPLEMENTAL WAGON SCORE

	Full Score	Given
Construction	30	....
Condition	70	....
	100	....

REMARKS:

Fig. 69.

The local Department of Health of each municipality should see first of all that they have a satisfactory by-law with regulations as strict as conditions will warrant. It may be necessary to have prosecutions for those who persistently break or ignore the law but the general attitude should be educative and persuasive. Inspectors, chemists, bacteriologists, executive officers all have their services to render to the people in this very important field of public health work.

DEPARTMENT OF HEALTH, CANADA

Regulations made by Order in Council, under the Food and Drugs Act, 1920.

XVI. MILK AND ITS PRODUCTS.

1. *Milk, Natural Milk.*—Unless otherwise specified is the fresh, clean product obtained by the complete uninterrupted milking, under proper sanitary conditions of one or more healthy cows, properly fed and kept; excluding that obtained within two weeks before and one week after calving; and contains not less than three and one-quarter (3.25) per cent of milk fat and not less than eleven and three-quarters (11.75) per cent of total milk solids, and must contain nothing foreign to natural milk.

2. *Sub-Standard Milk.*—It is not forbidden to sell sub-standard milk; but milk of this character must not be sold as *Milk* but must be plainly labelled *Sub-Standard Milk;* and its content in fat and non-fat solids must appear on the label in conspicuous characters. Such label must be affixed to every container in which sub-standard milk is delivered to the consumer.

3. *Re-Made, etc., Milk.*—Is milk which has been reconstituted from the essential components of milk, namely milk fat, non-fat solids, and pure water by the agency of suitable machinery. It must contain not less than three and one-quarter (3.25) per cent of milk fat, and not less than eleven and three quarters (11.75) per cent of total milk solids; and must contain nothing foreign to natural milk.

4. *Skimmed or Decreamed Milk, Separated Milk, Machine Skimmed Milk, any other term describing skimmed milk.*—Is milk from which a part or all of the milk fat has been removed. It contains not less than eight and one-half (8.50) per cent of non-fat solids.

5. *Pasteurized Milk.*—Is milk that has been heated to a temperature of between one hundred and forty (140) degrees Fahrenheit and one hundred and forty-five (145) degrees Fahrenheit and held at this temperature under agitation for a period of from twenty (20) to thirty (30) minutes and then immediately cooled to forty-five (45) degrees Fahrenheit or lower and shall have a temperature not above fifty-five (55) degrees Fahrenheit, when delivered to the consumer, at which time it shall contain not more than one hundred thousand (100,000) bacteria per cubic centimetre.

6. *Sterilized Milk.*

7. *Certified Milk.*—Milk sold as certified milk shall comply with the following requirements:

(a) It shall be taken from cows semi-annually subjected to the Tuberculin test and found without reaction.

(b) It shall contain not more than 10,000 bacteria per cubic centimetre from June to September, and not more than 5,000 bacteria per cubic centimetre from October to May inclusive.

(c) It shall be free from blood, pus, or disease producing organisms.

(d) It shall be free from any disagreeable odor or taste.

(e) It shall have undergone no pasteurization or sterilization and must be free from chemical preservatives.

(f) It shall have been cooled to 45° Fah. within half an hour after milking, and kept at that temperature until delivered to the consumer.

(g) It shall contain 12 to 13 per cent of milk solids, of which at least 3.5 per cent is fat.

(h) It shall be from a farm whose herd is inspected monthly by the veterinarian, and whose employees are examined monthly by a physician.

CREAM

15. Cream is that portion of the milk, rich in fat, which rises to the surface of the milk on standing, or is separated from it by centrifugal force, is fresh and clean and (unless otherwise specified) not less than eighteen (18) per cent of milk fat.

16. When guaranteed to contain another percentage of milk fat than eighteen (18) it must conform to such guarantee.

17. Cream must be free from gelatine, sucrate of lime, gums or other substances added with a view to give density, consistency or apparent thickness to the articles.

18. *Cream* must contain no preservative of any kind, except that it may contain Boric Acid not in excess of one part in four hundred (1 in 400) and the presence of the preservative must be declared.

19. *Evaporated Cream, Clotted Cream, Condensed Cream,* or any other preparation purporting to be a special cream, except Ice Cream, must conform to the definition of cream, and must contain at least twenty-five (25) per cent of milk fat.

ICE CREAM

26. *Ice Cream* is a frozen product made from cream and sugar with or without harmless flavoring and coloring materials and with or without gelatine, gum tragacanth, or other harmless stiffening materials, in amount less than two (2) per cent; and contains not less than seven (7) per cent of milk fat.

27. *Fruit Ice Cream* is a frozen product, made as described under Ice Cream but containing sound, clean and mature fruit. It must contain not less than six (6) per cent of milk fat.

28. *Nut Ice Cream* is a frozen product, made as described under Ice Cream but containing sound, non-rancid nuts. It must contain not less than six (6) per cent of milk fat.

MISCELLANEOUS MILK PRODUCTS

31. *Milk Powder* is the soluble powder product made from milk and contains, unless otherwise specified, not less than ninety-five (95) per cent of milk solids, and not less than twenty-six (26) per cent of milk fat.

32. *Skimmed Milk Powder, Separated (machine skimmed) Milk Powder,* is the soluble powder product made from skimmed milk, separated (machine skimmed) milk and contains not less than ninety-five (95) per cent of milk solids. The word Skimmed shall appear on the label in letters not less than one-quarter of an inch in height.

33. *Malted Milk* is the product made by combining whole milk with the liquid separated from a mash of ground barley malt and wheat flour, with or without the addition of sodium chloride, sodium bicarbonate, potassium bicarbonate in such a manner as to secure the full enzyme action of the malt extract and by removing water. The resulting product contains not less than seven and one-half (7.5) per cent of butter fat, and not more than three and one-half (3.5) of moisture.

34. *Homogenized Milk* is milk which has been treated by a machine known as a homogenizer. By the action of this machine the fat globules of milk are

broken, and the fat tends to remain in permanent emulsion. The food value of the milk is not affected by this treatment; and its constants remain as in section 1.

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Extracts from the legal standards for milk, cream and some miscellaneous milk products.

CHAPTER XV

FOODS

By H. M. Lancaster, B.A.Sc.

A food consists essentially of material which the body can utilize for the construction and repair of tissues for the maintenance of the body temperature, or as a source of energy for the work of performing body functions such as the respiration and the circulation of the blood, and also as a source of energy for carrying on the ordinary activities of life. Early studies in nutrition based almost entirely upon the principles of calorific values and balancing of rations, while productive of a great amount of good in preventing food excesses and deficiencies, were obviously incomplete. Even when attention was drawn to the consequences of defective diet such as one containing insufficient variety of protein or an insufficient supply of calcium and phosphorus, conditions all too common in modern dietaries, there was still a lack of satisfactory explanation for some of the complications encountered. The discovery of vitamines and their importance in nutrition has supplied additional information which is proving very useful.[5] The most recent tendency, except in institutional work, is to draw away somewhat from a rigid calculation of dietaries based on food requirements as judged from calorific values and to depend more upon maintenance of normal growth and body weight. Vitamines are receiving great attention.

Diet has a bearing upon the causative factors in many diseases such as scurvy, pellagra, and beriberi. It is also important in the treatment of other diseases such as diabetes, tuberculosis, rheumatism and nephritis. Other less well defined conditions such as derangements of general metabolism, dental caries and pyorrhea alveolaris, while not due to any one specific cause, are undoubtedly aggravated if not initiated by faulty diet.

Among primitive races the food is usually made up of a comparatively few articles. Civilization, however, with its improved methods of transportation, has developed an enormous complication of menus, the food supply being drawn from many sources and cli-

mates. Indeed it appears that the modern tendency is to make dietaries *too* elaborate, to pay too much attention to manufactured foods which are easily prepared for the table, with the result that our foods are widely different from the natural foods which man consumed for many generations. The processes of evolution are unable to keep pace with the over-rapid artificial alterations in the food supply.

Those individuals who are not directly connected with the production of food are dependent entirely upon supplies handled by others, many of whom make their own living thereby. Those who manufacture or deal in foods are liable to consider only their own profits and to ignore the consequences which the consumers must bear. *The greatest asset of any nation is its people* and the building up of a sturdy race is a matter of primary importance. In spite of all methods applied to the prevention and treatment of specific diseases, failure is inevitable if there is not an adequate supply of food properly utilized. It is important then to study the ways and means of maintaining a food supply which is satisfactory both as regards quantity and quality. As applied to foods, "quality" refers not only to nutritional value but also to freedom from fraudulent sophistication, injurious chemicals, harmful decomposition products, animal parasites, pathogenic bacteria and their products of growth.

FOOD ADULTERATION

For the reasons outlined above those concerned with public health measures cannot ignore their responsibilities in connection with the fraudulent adulteration of food. There was a time when it was generally considered that the activities of such officials should be limited entirely to problems directly concerned with communicable diseases but the field of preventive medicine is much broader than that and should include also the control of foods from what might be called the chemical standpoint.

There are some forms of adulteration commonly known and frequently spoken of more or less jocularly—such as charcoal in the pepper, peanut shells in the breakfast foods, hay seeds in the jam, sand in the sugar, etc. These were more or less simple and comparatively easy of detection. But nowadays food adulteration has

developed into an art and is practiced under advice from men with scientific and technical training. If left to themselves, there would be no limit which unscrupulous food dealers and manufacturers would not exceed. For this reason it is necessary in many cases to resort to measures of compulsion rather than persuasion.

Legislation covering food control is always more or less in a state of flux. New complications are continually arising, necessitating amendments, extensions and elaborations. In both Canada and the United States there are federal acts and regulations designed for this purpose. The Canadian Meat and Canned Food Act and the regulations issued thereunder are defined in a pamphlet of 34 pages; the regulations made by order in council under the Food and Drugs Act cover 32 pages. The corresponding pamphlets for the United States contain about 125 pages. In addition there are a great many circulars issued from time to time with special regulations necessary for meeting the requirements of food control as they arise. These publications are obtainable from the Government Departments concerned and are very instructive. Provision is made for inspection, analysis, prosecution of offenders and penalties on conviction.

POISONOUS FOODS

There are some plant and animal tissues which are inherently poisonous to man. Poisonous fungi are responsible for a considerable number of deaths every year. The edible mushrooms, sometimes referred to as "vegetable beef steak," are wholesome but there are some closely related varieties which contain toxic substances. The fungus known as *Amanita phalloides* is responsible for the majority of fatal cases of this kind. Cooking does not destroy the toxin which shows its action in fatty degeneration of the liver, the kidneys and the muscles of the heart. It is stated that in the vicinity of New York there were twenty-two deaths from mushroom poisoning in one ten-day period (1911). Rather exceptional conditions caused a prolific growth of the fungi at that time. While the edible species are wholesome and nutritious, unknown varieties should be used with great caution.

Potato poisoning is comparatively rare. A number of cases of illness after eating potato salad were no doubt caused by an infec-

tion and not by any constituent of the potato itself. The tubers do develop a specific chemical compound (Solanin) which is poisonous, but this takes place only when they become green through exposure to light and air during their period of growth or are allowed to sprout very heavily to the green leaf stage.

There is little definite knowledge concerning the specific poisons said to be present in animal tissues such as some kinds of fish and molluscs. Many so-called cases of poisoning from these sources have been caused by pathogenic bacteria or their products of growth which have gained entrance to the food through the medium of contaminated water or from careless handling by persons suffering from disease or by carriers. Fortunately these poisonous fish are comparatively rare and poisoning from this source is not likely to be general or serious in this country. The same cannot be said of other poisons which gain entrance to the food during the processing or storage in faulty containers, careless handling or by deliberate addition for purposes of preservation. Our most valuable foods are the highly nitrogenous foods and they are especially subject to decomposition by bacterial action. The chemical changes produced by putrefactive bacteria can be prevented or arrested by various devices.

METHODS OF PRESERVATION

Many of these were employed by man in early times when it was necessary to carry over food from times of superabundance to those of scarcity. The practice of drying and smoking and pickling of meats, the drying of fruits and vegetables, preservation by means of spices, sugar and vinegar all come under this category. These are still permissible methods and are regarded as harmless probably because man has accustomed himself to them. Canadian legislation, however, prohibits the use of such substances as formaldehyde, betanaphthol, abrastol and fluorine compounds. It is permissible to use the following compounds in amounts not greater than those specified in each case: boric acid, one part in two hundred; benzoic acid, one part per thousand; salicylic acid, one part per five thousand; sulphurous acid and sulphites, one part in ten thousand in beverages, one part in two thousand in solid foods. The presence of these preservatives must be declared on the labels and

permission to use them is tentative. Such permission may be withdrawn as soon as evidence is submitted proving them injurious. No preservatives are permitted in milk, or in foods for the use of children and invalids.

The argument in favor of preservatives is based on the statement that if perishable foods cannot be consumed in the fresh state the danger from the small amount of preservative required would be much less than that from the decomposition products, or from microorganisms which would otherwise multiply unrestrained.

The most satisfactory method of preserving perishable food in its natural condition is by means of cold storage. While bacteria are not destroyed by refrigeration, their multiplication is arrested and that is the most important point. Freshly slaughtered animal meat is not so tender, so palatable or so easily digested as meat which has been "hung" for a period of two weeks in a refrigerator. Antolytic enzymes are thus given time to effect a partial hydrolysis of the protein. Moreover, cold storage over longer periods serves the purpose of saving the excess at times of greatest abundance for periods of nonproduction. The abuse of cold storage for purposes of hoarding for excessive profits is to be avoided. Several commissions have reported on this subject and the work is not yet completed. When all the experimental evidence has been collected it will no doubt be possible to establish conditions of storage and to specify periods of time of storage for the various classes of foods.

COLORING

Other additions may be made to food for the purpose of improving its appearance. The addition of coloring matters may be made to satisfy a more or less childish whim of the consumer, but has been considered of sufficient importance to receive legal recognition. According to Canadian regulations harmless coloring may be added to cheese, ice cream, butter and confectionery, provided such coloring does not conceal damage or make the article appear of greater value than it really is. There are also ten coal tar dyes which are permissible for food coloring, it being stipulated, however, that the specified dyes must be of such quality that the arsenic content

shall not exceed ten parts per million. The amount of such dye used must not be in excess of one part per 3500 parts of food.

Coloring canned vegetables with copper is no longer permitted. The process of sterilization for vegetables such as peas necessitates heating to a temperature which will destroy the spores of certain types of bacteria. The natural coloring matter (chlorophyll) is sacrificed in the process. It may be simulated by adding copper sulphate, and in fact the use of copper for this purpose was at one time permitted, but is now prohibited in both the United States and Canada.

POISONOUS METALS

Other metals may enter the food from containers. Lead, zinc, copper, antimony and arsenic appear to be the most dangerous. The following regulation from the United States standards is intended to provide means of protecting the public in this matter:

"Suitable containers for keeping moist food products, such as sirups, honeys, condensed milk, soups, meat extracts, meats, manufactured meats, and undried fruits and vegetables, and wrappers in contact with food products contain on their surfaces, in contact with the food product, no lead, antimony, arsenic, zinc or copper, or any compounds thereof, or any other poisonous or injurious substance. If the containers are made of tin plate they are outside-soldered and the plate in no place contains less than one hundred and thirteen (113) milligrams of tin on a piece five (5) centimeters square or one and eight-tenths (1.8) grains on a piece two (2) inches square. The inner coating of the containers is free from pin holes, blisters and cracks. If the tin plate is lacquered, the lacquer completely covers the tinned surface within the container, and yields to the contents of the container no lead, antimony, arsenic, zinc or copper, or any compounds thereof, or any other poisonous or injurious substance."

Arsenic is almost universal in its occurrence and is very likely to be present in products prepared by processes employing sulphuric acid made from pyrites. With this in mind we can appreciate the necessity of the Canadian regulations specifying the maximum arsenic content permissible in various materials used in preparing foods and beverages as follows: "Arsenic (arsenious acid,

As_2O_3) shall not be present in herein-named articles in excess of the following amounts:

Citric Acid	1 part per million
Tartaric Acid	1 part per million
Cream of Tartar	2 parts per million
Bicarbonate of Soda	2 parts per million
Boric (Boracic) Acid	4 parts per million
Baking Powders	2 parts per million
Coal Tar Colors used in foods or drugs	10 parts per million''

DECOMPOSITION PRODUCTS

When foods decompose by bacterial action a great variety of chemical changes take place. Carbohydrates undergo hydrolysis and are ultimately broken down into such products as lactic acid, acetic acid, butyric acid, and carbon dioxide. Lactic acid is the chief product. Proteins also are hydrolyzed through a series of cleavage products, viz., proteoses, peptones, polypeptides and amino acids. The end products include phenolic bodies, amines, ammonia and hydrogen sulphide. Many of these compounds are offensive to the sense of smell and their presence in very noticeable quantities is commonly taken as evidence that the food is not fit for use. There are some inconsistencies in this regard. In cheese, for example, we have a milk product which is indigestible when freshly made. It must undergo a process of curing or "ripening" before it reaches its best condition in which the greater part of the casein is in a soluble form. This curing process is essentially associated with bacterial action, the nature and quality of the product being dependent upon the flora, and the enzymes present, as well as upon the temperature, air supply and period of storage. There are some recorded cases of poisoning from cheese in which the effects have been ascribed to a protein cleavage product known as *tyrotoxicon.* The majority of ill effects from defective cheese appear to be due to bacteria and their products of growth. The colon bacillus (or closely related forms) has been responsible for causing trouble in some instances.[12]

Very few cases of disease have been definitely traced to eggs although they are seldom free from bacteria and during storage at ordinary temperatures undergo extensive alterations in structure and in the character of the nitrogen compounds. Indeed, in some

countries, eggs are considered a great delicacy after they have been kept for years. Although it is doubtful if one could persistently eat such ripened foods in considerable amounts every day for any great length of time without some ill effects being shown, still so far as poisoning from protein split products is concerned, the danger does not appear to be very great. This is especially true in this country where high meats are not popular, and in other foods, such as eggs, freshness is generally appreciated.

For the same reasons, ptomaine poisoning in the proper sense of the term is very rare. The true ptomaines are amines formed by the breaking down of proteins. Two of these, *putrescin* [$NH_2(CH_2)_4NH_2$] and *cadaverin* [$NH_2(CH_2)_5NH_2$] are well-known diamines. While they have a definite physiological action when ingested by human beings, they are so offensive that there is very little danger of poisoning therefrom. As will be shown later, the so-called ptomaine poisoning is nearly always due to infection with bacteria or to products of bacterial growth more properly defined as toxins.

FOOD POISONING

The popular conception of food poisoning is that of digestive disturbances more or less severe coming on immediately or at least within twenty-four hours after partaking of the food in question. The usual tendency is to blame some portion of the latest meal, but the real source may have been food consumed 48 hours previously. In this connection it should be remembered that the terms "poison" and "poisonous" are capable of very general interpretation. In one sense, common salt is poisonous as disturbances follow the swallowing of a large amount of it at one time. Again, there are individuals with idiosyncrasies for various proteins, both animal and vegetable. Some persons develop a rash shortly after eating strawberries; others are very sensitive to eggwhite—a very small amount of it being sufficient to cause vomiting and extreme prostration. There are many such cases of hypersensitiveness to proteins. These anaphylactic symptoms are alarming but not very often fatal and in many cases gradually decrease in severity in repeated attacks. In fact it sometimes happens that a fair degree of tolerance for the protein concerned may be developed.

In many cases of food poisoning where a number of individuals have been taken ill after eating together at the same meal, the information necessary to locate the source of the trouble is not always obtained. The tendency is to blame some one article of food, but the conclusion should not be final until all the available facts have been taken into consideration. The laboratory examination should include not only that of the food samples but also in many cases tests such as the Widal reaction and examination of feces of those who are suffering from the attack, and of those who handled the food, tracing it back to its source if possible. The majority of these ill-defined cases are concerned with nitrogenous foods. The effects are due either to microorganisms which are taken into the body in considerable numbers and multiply there, or to bacterial toxins produced outside the body. These toxins are of unknown composition, but are metabolized products of the bacterial cells. They vary greatly in their conditions of formation as regards media and temperature, but are all comparatively easily destroyed by heat. The toxin-producing bacteria concerned with food poisoning are: *Bacillus enteritidis* (Gaertner), *Bacillus suipestifer* and *Bacillus paratyphosus B*. There are a number of bacterial forms which appear to shade into each other, their definite distinction being very difficult, in fact in some cases impossible. Gaertner's bacillus, thought by some to be identical with *paratyphosus B,* was originally isolated from infected meat obtained by the slaughter of animals suffering from disease. It produces an endotoxin which is liberated by gentle heat. In the process of cooking as ordinarily practiced, the temperature reached in the inner portions of large masses of food is quite insufficient to sterilize. It is possible that the immediate effects coming on within a few hours after the food is eaten may be due to such liberated toxin; the subsequent effects are due to the organisms which have multiplied in the alimentary tract, the original infection coming from bacterial survivors of the cooking process or from organisms added between the time of cooking and the time when the food was eaten. It might be noted that the greatest number of food poisonings have been traced to cold meats and salads which have been allowed to stand.

Going back to possible sources of the trouble, it is found then that diseased animals should not be slaughtered for food. Diarrhea

in cattle, cholera in swine, for example, may cause the meat of such animals to be dangerous from the standpoint of these ill-defined forms of food poisoning. Inspection of the animals before slaughter is one of the most certain means of prevention. Bacteria of the enteritidis group are commonly found in the intestines of rodents, and it is possible that some epidemics have been caused by infection of the food by organisms from the feces of rats and mice. Foods which have been cooked or which are to be used at the table without being heated should be protected from such animal pests.

There are also human beings who are carriers of organisms of the paratyphoid group. The location of a carrier among those concerned with the handling and preparation of the food for a meal which has been followed by a number of cases showing gastro-intestinal symptoms and diarrhea, is by no means a simple matter. Organisms which are possible sources of trouble may be isolated from some of the food (the nitrogenous foods are most frequently the offenders), the same organism may be obtained from the stools of those showing symptoms.[13] Identification can be confirmed by agglutination tests on the blood sera. The blood sera of carriers may not respond to the agglutination test. Examination of the feces is often unsatisfactory because of the fact that discharge of the organisms may be intermittent. For these reasons, the literature on this topic is much involved, and will remain so until a sufficient number of cases can be investigated thoroughly and systematic reports made.

Typhoid fever may be caused by food, the organisms gaining entrance to the food by means of contaminated waters (as in shell fish), polluted soil (infecting green vegetable salad material), or by careless handling on the part of those who are discharging the organisms from their own bodies. It is through the food supply that carriers of paratyphoid and typhoid fevers do the greatest damage. In fact, legislation prevents such afflicted individuals from handling milk or other foods. The disposal of carriers is still a perplexing problem. In the interests of the people, they should be prevented from working in kitchens, restaurants or other places where they may do untold damage.

Other diseases such as tuberculosis, diphtheria, septic sore throat, are sometimes caused by infected food. Tubercle bacilli of the

avian or bovine types, dangerous types of streptococci and staphylococci may be present in the meat of animals suffering from the various diseases to which they are subject. As the infections set up in man are often slow in demonstrating themselves, it is very difficult and in many cases impossible to prove that the food was the means of conveying the organism to the body, although such may have been the case.

In connection with food poisoning, canned foods have received rather more blame than is actually just. The majority of such cases have arisen from improper handling of the food after the containers have been opened. The process of canning, if properly carried out, is a very effective and satisfactory method of preserving food. Domestic canning is a source of economy and of convenience. Factory canning must be under inspection if the best results are to be obtained. As a sacrifice of at least a portion of the vitamines is inevitable if sterilization has been accomplished, canned foods should not make up the major part of a dietary for any length of time. Such foods should be supplemented with other fresh material which has not been altered by heat.

Animal parasites such as *Trichinella spiralis,* and the various tape worms or cestodes (*Tenia saginata* in beef cattle, *Tenia solium* in hogs and *Hymenolepis nana* developed in rats), may be transmitted to man by means of food. There is also a possibility of the hookworm infection by the mouth, although the common route seems to be through the skin of the feet. Trichinosis, caused by Trichinella spiralis, is very difficult to treat satisfactorily and cures are very uncertain, but prevention is simple. All meats should be thoroughly cooked before being eaten, *immediately* before, if possible. The practice of eating raw meat in any form is not to be encouraged. If meats are kept for a time after they are cooked, the storage of them should receive special attention.

BOTULISM[8, 9, 10, 13]

Of comparatively recent appearance on this continent is the disease known as *botulism,* at one time popularly referred to as "sausage poisoning." This is quite different from the food poisoning referred to above in that gastrointestinal symptoms are com-

monly, in fact usually, very slight or entirely absent. The nervous system is, however, affected, as shown by symptoms such as dizziness, diplopia, difficulty in chewing and swallowing, etc.; temperature, respiration and pulse remain practically normal. Symptoms may appear in from three to forty-eight hours. The eye symptoms are regarded as of special diagnostic value and in fact the impairment of vision is often so marked that it is suggestive of poisoning by methyl alcohol. The organism responsible for this is *Bacillus botulinus,* a spore-forming anaerobe, first isolated in 1895 by Van Ermengem from a portion of a ham which caused fifty cases of poisoning in Belgium. In the process of curing, this ham was kept for a time in brine, under anaerobic conditions. Others from the same source and batch but not covered by the brine were consumed without complications. In fact all the reported cases of toxic effects from this organism are connected with improperly cured or partially sterilized foods subsequently stored under conditions favorable to the growth of anaerobes. Bacillus botulinus multiplies most rapidly at 22° C. and differs from all the organisms referred to above in that it cannot multiply inside the human body. Its injurious effects are due to a powerful toxin produced during storage. This toxin is a true toxin, characterized by instability (easily destroyed by heat at 80° C. for thirty minutes), powerful action even in small doses (symptoms produced in animals by injection of 0.0001 c.c. of a filtered broth culture), and has a corresponding antitoxin, as shown by animal experiments. Very little is definitely known as to the extent to which the organism is disseminated in Nature; it may be present in the soil or in the intestines of animals, and only occasionally finds favorable conditions for the production of its toxin; on the other hand it may not be present in many localities. The definite diagnosis of botulism in California, Arizona and Michigan[13] may indicate that it is gradually spreading. The presence of the toxin in canned vegetables such as beets, string beans and spinach and in olives has caused considerable alarm. If the danger appears very great as shown in occasional cases of botulism in new localities, the necessary measures for safety are to be found in the careful attention to canning processes, the avoidance of all off-flavored canned foods, and heating all canned meats and vegetables immediately before use. Recent experiments on the development of a satis-

factory antitoxin for purposes of treatment and of prophylaxis of botulism have not proved very successful.

MEAT INSPECTION[4, 14]

In Canada, federal legislation places the control of meat inspection under the Department of Agriculture, and provides for the inspection of all meats and canned foods prepared for export either to places outside of Canada, or for interprovincial trade. The laws of the United States likewise provide for inspection of all meat prepared for export from the United States, or for interstate trade. The complaint is sometimes made that such provisions are inadequate in that there is no federal control over meats prepared for sale within the Province or State. This matter is for the States and Provinces to deal with. As a matter of fact, even in States or Provinces where meat inspection is not well organized, a great part of the meat sold in the larger cities comes from abattoirs and packing houses under federal inspection. It is the duty of those concerned with the control of foods to see that there is proper provision made to cover local conditions. It should not be forgotten that *a few inspectors at the place of the preparation of food supplies can accomplish more by prevention than can possibly be achieved by a whole army of inspectors, chemists, bacteriologists, and pathologists working on the problem after the damage has been done.*

The following extracts from the federal regulations bear upon some of the more important points: Every animal about to be slaughtered shall be examined by a veterinary inspector in the yards or pens of the establishment prior to entering the killing floor. Animals found to be diseased or suspected of being diseased shall be tagged and killed separately at the end of the regular kill. Inspectors shall make a thorough inspection at the time of slaughter of the carcass and all portions thereof. If the examination reveals no ground for detaining or condemning the same, the inspector shall pass and mark in the required way the carcass, including portions to be used for preparation of sausage and other forms of food. If it is considered that further examination of the carcass is necessary it is marked "Held," and kept in separate store until the investigation can be completed. Laboratories are provided for the necessary pathological, bacteriological and other examinations.

Should the subsequent inspection show the carcass or any part thereof to be in any way unfit for food, such carcass or portion is to be marked "Condemned." Condemned meat is usually made into fertilizer. Carcasses which may be rendered into lard or tallow are marked "Rejected" at the time of inspection. The entire carcass, as also the blood, of any animal affected with any of the following diseases or conditions is to be condemned or tanked or otherwise disposed of (not to be used as food): Anthrax, Black leg, Pyemia or Septicemia, Rabies, Tetanus, Malignant Catarrh, Hog Cholera, Swine Plague, Texas Fever, Parasitic ictero hematuria, Inflammation (chronic or acute of any of the following tissues: lungs, pleura, intestines, peritoneum or uterus), Traumatic Pericarditis, Jaundice, Uremia, abnormal sexual smell, Parturition (carcasses of animals having within ten days given birth to young), Immaturity (every animal under three weeks of age), emaciation or anemia. The regulations include also rather elaborate outlines of principles for the guidance of inspectors in the following conditions: Tapeworm cysts, Tuberculosis, Actinomycosis and Actinobacillosis. It is impracticable to make hard and fast rules which can be applied to every case and to state definitely the point at which the disease becomes noxious or the flesh unwholesome. In many cases it is sufficient to discard portions or organs showing definite lesions. Carcasses extensively affected with and portions showing the following lesions or conditions are to be condemned: abscesses, bruises, tumors, parasitic infection. All animals found dead or in a dying condition upon the premises of any abattoir shall be condemned. Pregnant animals are to be tagged "Held." They shall not be slaughtered at that time nor for ten days after parturition, but may be removed for stock or dairy purposes provided they are not affected with and have not been exposed to infection or contagious disease.

Canned foods should be made from sound material, should be prepared in a cleanly and sanitary manner, and should be sold under labels which are free from all false or misleading statements. The federal Food and Drugs Act of the United States applies only to food and drugs which are shipped in interstate commerce, manufactured, or sold or offered for sale in the District of Columbia or the Territories, or which are exported from or imported into the

United States. Products which are shipped in interstate commerce are also subject to the laws of the State into which they are shipped for consumption. Products which do not enter into interstate commerce but are manufactured and consumed within the borders of one State are not subject to the requirements of the Federal Act, but must comply with the laws of that State.

In Canada the administration of the Food and Drugs Act (1920) is under the Department of Health.

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CHAPTER XVI

DIET, DIETARY DEFECTS, AND DEFICIENCY DISEASES

By Andrew Hunter, M.B.

A. THE FOOD REQUIREMENTS OF MAN

It is the general function of food (1) to promote the growth of the young individual at a normal rate to full stature; (2) to maintain the adult, in the performance of his daily work, at his normal body weight.

In order to attain these objects it is necessary and sufficient that the diet as a whole, whatever the details of its composition, be digestible, free from directly harmful ingredients, and capable of supplying the following positive requirements:

(1) *Protein* sufficient in amount and adequate in quality to furnish during the growth period the necessary new material, and to make good at all ages the unavoidable wear and tear of the tissues;

(2) Physiologically available *energy* in such quantity as will balance the energy expended daily in heat, mechanical work, and other forms;

(3) *Mineral constituents* of such kind and in such amounts as are required in the construction of bones and other tissues, or to replace the daily loss of inorganic elements in the excreta;

(4) A certain minimum supply of the essential accessory food materials, commonly known as *vitamines,* the exact nature of which is yet unknown.

These conditions can be satisfied by many possible combinations of natural foodstuffs; and it is not necessary, or even particularly desirable, that the dietary habits of human communities should be everywhere and always alike. That they do actually vary is a matter of every day knowledge. Circumstances of climate, custom, wealth, geographical location, and the like, have produced in this respect the greatest diversity; yet it has not appeared that health and vigor are the monopoly of any race or of any region of the globe. The precise structure of a diet, by whatever factors of choice or compulsion it may have been determined, is therefore a matter of

secondary importance. So long as it meets the four fundamental requirements just specified, any diet will be physiologically adequate.

Unfortunately these requirements are not in practice invariably satisfied. Habit and appetite are not by themselves reliable guides; and it sometimes happens, either by force of circumstances or through injudicious selection, that the diet, now of a group, now of an individual, lacks one or another of the qualities essential to perfect nutrition. The consequences are manifested in imperfect growth, various more or less sharply defined states of malnutrition, or definite pathological conditions described as "deficiency diseases."

To understand these conditions and the manner in which they may be prevented, it will be necessary to consider in somewhat greater detail the different requirements of human nutrition and the most suitable ways of assuring their practical realization.

1. The Requirement of Protein

The *maintenance requirement* of protein, or the *protein minimum,* is the smallest quantity that will suffice, under the most favorable circumstances, to preserve the body from protein loss. It may be determined by feeding a diet of constant and adequate energy value, of which the protein content is periodically diminished or increased until it is just enough, and no more, to maintain the subject in nitrogen equilibrium. There have been performed, according to Sherman,[1] 109 approximately satisfactory experiments of this nature, involving observations upon 29 men and 8 women. When the results of these experiments are recalculated to the common basis of the "average man" of 70 kilograms they indicate a requirement varying from 21 to 65 grams daily. Their general average is 44.4 or, in round numbers, 45 grams; but upon a critical survey of the individual data it appears that the higher estimates are those most likely to be in error, and that the true minimum is probably not above 42, possibly as low as 35 grams. The actual protein consumption of all classes and conditions of men, except only those prevented by poverty or other restraints from having a reasonably free choice in the matter, is considerably greater than this. Dietary studies conducted almost all over the world—in Asia as well as in

Europe and America—combine to show that instinct and appetite everywhere prescribe an amount of protein three, four, or even five times as much as the maintenance minimum. Even among groups of sedentary habit or occupation the daily intake of protein seldom falls below an average of 90 grams, while with men engaged in strenuous labor it may rise above 175. If a universal habit may be assumed to indicate a universal physiological need, then the protein requirement for perfect nutrition must lie, in round numbers, between 100 and 150 grams.

The striking difference between the maintenance requirement and the dietary habits of people in comfortable circumstances has led some authorities to inquire whether the latter are not fundamentally unsound. Chittenden[2] in particular argues that the excess is directly injurious, and that a greater economy in the use of protein would result in general physical and even intellectual improvement. He himself has lived for many years on a diet yielding an average nitrogen output in the urine of only 5.7 grams, implying the daily metabolism of only about 35 grams of protein; and he claims not only to have maintained his weight on such a ration, but to have gained in health, bodily efficiency, and mental alertness. In his opinion an allowance of 60 grams of protein leaves an ample margin for all emergencies.

The other side of the argument has been ably presented by McCay,[3] who points out that the régime advocated by Chittenden has been forced for generations upon the inhabitants of Bengal, and that the result of this large scale experiment upon the physique and the moral qualities of the race hardly recommends the universal adoption of Chittenden's standard. Those races of India which equal the European in physical development, endurance and martial courage, are those which possess also the European standard of diet. McCay argues therefore that the ultimate effects of a diminished protein intake could not fail to be disastrous.

It will be apparent that the *optimum* protein requirement of man cannot in the present state of our knowledge be laid down in any absolute terms; but, as the possible effects of underestimating it seem on the whole more alarming than those of the opposite error, it will probably be safest in the meantime to abide by the prescription of custom. Of the many more or less arbitrary standards con-

structed upon this basis Atwater's is probably as good as any; it allows 100 grams of protein for those of sedentary occupation, 125 for those doing a moderate amount of muscular work, and 150 for those engaged in arduous labor.

There is another aspect of the protein problem, of which such standards fail to take specific account. It is not enough that the *quantity* of protein be ample; its *quality* also must be suitable. Individual proteins differ in the nature and proportions of the amino-acids which enter into their constitution. Some of them, described as "imperfect" proteins, lack entirely amino acids which are indispensable in certain processes of nutrition. Thus a protein like the gliadin of wheat, which lacks the amino acid lysine, is incapable of bringing about *growth*, although still adequate to the *maintenance* of an adult animal. Proteins like gelatine, or the zein of corn, which lack the amino acid tryptophane, are useless even for maintenance; so that no amount whatever of gelatine or zein would meet the protein requirement of the body. Even among the so-called "complete" proteins, which can furnish every necessary amino acid, there are differences of biological value; since in one or another of them some essential amino acid may be present (like cystine in casein) in such small proportion that, to furnish enough of it, a relatively large amount of the particular protein is required.

Of course no natural diet contains but a single protein. Even when, as may happen, the diet is so restricted that all its protein is derived from a single source, say a cereal like rice or a tuber like the potato, that source is certain to furnish at least two different proteins. Thus the gliadin of wheat is accompanied by glutenin, the casein of milk by albumin and globulin. Now it usually happens that proteins thus inevitably associated in food supplement to a greater or less extent each other's deficiencies; so that, for example, the *mixed* proteins of wheat are adequate for growth as well as maintenance, and the protein combination provided by milk has a greater biological value than casein alone. So constant are these supplementary relations that there is no single natural foodstuff known which could not, if consumed in sufficient amount, supply protein adequate for every requirement.

Advantageous as this provision is, it does not operate so exactly that all the naturally furnished combinations are of equal value.

None apparently are more fortunately adjusted for the purposes of animal nutrition, and none therefore more economical in feeding, than those offered in milk, eggs and meat. The protein mixtures of cereal grains have only one-third to one-half of the value of that of milk; while the proteins of legumes appear to be in general even less efficient for growth or maintenance than those of cereals. If, therefore, peas and beans, say, became under any circumstances the *only* source of protein in the diet, the amount that would have to be consumed to meet the protein requirement of the body would be exceptionally large. Physiologically such a diet would be exceedingly uneconomical. It might moreover in such a case very easily happen that the actual consumption would fall short of the requirement, so that nutrition and health would be seriously impaired. Conditions of this general nature are believed by some to be partly responsible for the disease *pellagra.*

It is rarely, though, that the proteins of the food are derived exclusively from any single source. It is therefore important to know that there exist also many supplementary relations between the protein mixtures provided by different foodstuffs. A food which by itself furnishes only proteins of inferior quality may form a very valuable adjunct to proteins of superior constitution but greater cost. Thus a combination in which two-thirds of the protein is furnished by wheat, and one-third only by meat, milk or eggs, is nearly as efficient as meat alone, and of course is very much cheaper. Even the food materials lowest in the scale—the seeds, tubers, and roots—supplement to some extent each other's protein deficiencies. Occasionally such combinations turn out to be quite exceptionally and unexpectedly efficient—as in the case of maize and flaxseed. There is, however, no better way of supplementing the poorer vegetable proteins than by adding to them milk, eggs or meat. One or another of these ought therefore, whenever possible, to supply part at least of the protein of the diet.

From what has been said it will now be obvious that 100 grams of "protein" in a diet does not, from the nutritional point of view, always mean precisely the same thing. The quality of the protein is an important factor in determining the necessary quantity. Especially is this the case in relation to the special demands of the growth period; and there can be little doubt that an inadequate

supply of suitable protein is a factor in many cases of malnutrition or imperfect physical development.

2. The Requirement of Energy

If the body is not to be compelled to consume its own substance, it must be supplied with energy equivalent to that which it is continually losing. It loses energy partly in the form of heat and partly in the form of mechanical work; it receives energy in potential form with the combustible materials of the diet. In dealing with the phenomena of nutrition it is convenient to measure these different forms of energy in terms of a common unit; and the one universally employed is the calorie, the unit of heat. The calorie meant is the large Calorie, the quantity of heat required to raise 1 kilogram of water from 0° to 1° C.

The total energy requirement is made up of the following components:

(1) The so-called basal requirement;

(2) The energy needed to balance the output involved in muscular and other functional activity;

(3) An additional quota to balance the extra heat production caused by the stimulating action of food.

(1) The *basal requirement* or *basal metabolism* is, in theory at least, the energy production inseparable from the merely vegetative life of the cells, apart from any functional activity; but since it is impossible to realize such a condition in the case of a complex organism like man, it means in practice the energy (heat) production in a state of complete muscular repose with the digestive tract empty of food. It is a quantity nearly constant for the individual, but varying, as might be expected, from one individual to another. According to the observations of F. G. Benedict[4] it amounts on the average to 1630 calories daily for men, and 1350 for women; or, expressed as calories per hour per kilogram of body-weight, to 1.07 for men, and 1.02 for women. During the period of growth it is relatively greater, and in old age a little smaller.

(2) The performance of external *work* means the expenditure of energy, and therefore an increase of metabolism and of energy requirement. The actual increase is much greater than the work performed; that is, only a fraction (one-fifth to one-third) of the

total additional energy liberated when work is done appears in the mechanical work itself. The remainder takes the form of heat.

The total increase involved in various specific acts of muscular exertion, and in many common employments, has been measured with considerable precision. For example, the exertion involved merely in sitting up requires an extra metabolism of 4 calories per hour; slow walking costs about 150 calories, and cycling about 500 calories per hour. Some of the data regarding occupations are to be found in the third column of Table LVIII. (In this table, from Becker and Hämalainen,[5] the increase due to work is calculated from an arbitrary rest value of 1.25 calories per kilogram per hour, and each result is an average from two individuals.)

TABLE LVIII

OCCUPATION	CAL. PER HR. AT WORK	HOURLY INCREASE DUE TO WORK	GROSS REQUIREMENT
Shoemaker	172	90	2700
Tailor	130	44	3000
Bookbinder	164	81	3100
Metal worker	218	141	3450
Painter	231	145	3550
Carpenter	224	140	3550
Mason	387	303	5000
Sawyer	476	388	5750
Sempstress	86	6	2000
Machine-Sempstress	111	40	2200
Laundress	236	169	2200
Kitchen maid	186	119	2850
Bookbinder	113	50	3300

(3) When a subject, whose metabolism has been measured under basal conditions, is given food, it is found that his heat production increases even in the continued absence of any voluntary muscular movement. This stimulating effect upon metabolism is known as the *dynamic action* of food. The specific effect in this respect of the different nutrients varies. The greatest increase is caused by protein; the metabolism of an amount of protein yielding 100 calories is calculated by Lusk[6] to stimulate the cells to produce an additional 45 calories of heat. The effect of carbohydrate or fat is much less. The general result with an ordinary mixed diet is that the output of energy (heat) is raised by about 6 per cent of the caloric value

of the food ingested. The requirement of energy is correspondingly increased.

With the data given it is possible to estimate the energy requirement for men or women in any given circumstances. Imagine, for example, the case of a carpenter working eight hours per day, spending two hours in walking, six hours at rest in a chair, and the remaining hours in sleep. The calculation would be as follows:

Basal requirement	1630 calories
8 hours work at 140 calories	1120 "
2 hours walking at 150 calories	300 "
6 hours sitting at 4 calories	24 "
	3074 calories
Add 6% for dynamic effect of food	185 "
Net total requirement	3259 calories

This is the amount of energy that would have to be actually absorbed. Since about 10 per cent of the energy of the food is generally assumed to be lost in the feces, it would be necessary to ingest an additional 326 calories; that would make the hypothetical carpenter's gross requirement in round numbers 3580 calories. The gross requirement of various occupations, calculated in a somewhat different way, is shown in the fourth column of Table LVIII.

Of the energy required a certain proportion will, of course, always be furnished by the protein of the diet, every gram of which yields in metabolism an average of 4.1 calories. With 100 grams of protein there would therefore be provided 410 calories. The remainder may be furnished either by carbohydrate, which yields 4.1 calories per gram, or fat, which yields 9.3, or, as usually, by a combination of both. These ingredients of the food, unlike the protein, have no other function than to provide energy. In this respect they act isodynamically, that is in proportion to their energy content, so that 1 part of fat is the equivalent of about 2¼ parts of carbohydrate. Theoretically it does not matter in what proportions the two are combined to make up the total requirement. Practically, for reasons of taste, digestibility, and financial economy it is customary to provide the greater part of the energy need in the form of carbohydrates.

3. The Requirement of Minerals

Human tissues contain, as apparently essential elements, not only C, H, O, N and S, which are furnished by the protein, fat, and carbohydrate of the diet, but also at least eight others—Na, K, Ca, Mg, Fe, P, Cl, and I—which are supplied partly at least in inorganic form, and may be, as far as we definitely know, successfully utilized entirely in that form.* The quantities of such mineral constituents essential for proper nourishment have not been studied so intensively as in the case of protein and energy. It is only for *calcium* and *phosphorus* that reasonably satisfactory standards can be said to exist. The minimum amount of calcium that will suffice to meet the maintenance requirement of a 70 kilogram man is probably about 0.45 gram; that of phosphorus, about 0.88 gram (Sherman).[7] To provide a reasonable margin the diet should therefore contain at least 0.7 gram of the former, and 1.3 grams of the latter. The requirement of each during the growth period, when new bone is in process of formation, will be relatively greater, but has not yet been accurately determined. It is of importance to recognize that the diets of urban populations on this continent tend, in respect of their phosphorus and still more of their calcium content, to approach or even to fall below the proposed margin of safety, and many instances of nutritional disorder, especially among children, are perhaps attributable to no other factor. There is no simpler or surer way of providing against a deficiency of both elements than by adding to the consumption of milk. Phosphorus can be conveniently secured also in cheese and eggs; calcium in green vegetables. A diet derived solely from meat, seeds (cereal and legume), tubers and roots, although it might provide for a time a varied and appetizing succession of meals, would be decidedly deficient in calcium; the further exclusion of the seeds would deprive it of most of its phosphorus.

The requirement of *iron* for the adult is said to be about 55 milligrams daily, but this is probably an exaggerated estimate. Regarding the other inorganic elements it would appear that very small quantities indeed may suffice to meet even the requirements

*Iron is a probable exception to this statement.

of growth; but it is not yet possible to state with precision, either for K, Na, Mg, Cl or I, the minimum intake compatible with normal nutrition.

4. The Requirement of Vitamines

Ten or fifteen years ago it would have been thought that, if a diet met all the requirements considered in the preceding paragraphs, it could not fail to serve every purpose of nutrition. This is now known to be by no means a necessary consequence. If proteins, fats and carbohydrates be carefully isolated from the many other substances with which they are associated in natural foodstuffs, if they be then combined in suitable proportions with the necessary mineral ingredients, and if the mixture be fed in quantity sufficient to meet the demand for energy, the result will be total nutritive failure. It follows that the purification of the longer known nutrients involves the removal of a substance or substances which are, equally with them, essential components of a complete diet. The nature of these substances is as yet unknown, and they have not been isolated in pure form. They have been variously named "vitamines," "accessory food factors," "food hormones," etc. They are apparently rather widely, although irregularly, distributed among natural foodstuffs, so that they are partaken of unwittingly in the customary mixed diet of most communities. This, together with the surprisingly small quantity of them which, as it appears, will meet the requirements of nutrition, accounts for the fact that their existence and importance were not earlier recognized.

Of these essential vitamines there are believed to be at least three, which are distinguished by the following nomenclature:

(1) The fat-soluble, or vitamine A.

(2) The water-soluble, or antineuritic, or antiberiberi, or vitamine B.

(3) The antiscorbutic, or vitamine C.

As to the actual requirement of these substances, it is impossible, so long as we cannot isolate and purify them, to make rigidly quantitative assertions. The best that can be done is to name for each the principal foodstuffs in which its presence has been demonstrated,

and to indicate as nearly as may be their relative richness in that regard. It will then be possible to judge in what way the provision of an adequate amount of each may be most readily assured.

1. The *fat-soluble vitamine A* is most abundant in certain animal fats, of which the best are butter and cod liver oil, and in the fat-rich yolk of eggs; it is found in considerable quantity in glandular organs like the liver and kidney, in the embryo of wheat and presumably other seeds, in fresh green vegetables like cabbage, lettuce and spinach, and of course in cream, whole-milk, and cheese prepared from the same; there are appreciable amounts in whole-meal bread, in peas and beans, in carrots, and in nuts; it is absent or practically absent from vegetable oils, such as olive and cotton-seed, from lard and the hydrogenated fats sold as lard substitutes, from meat, white bread, potatoes, oranges and yeast. The best way of ensuring its consumption in sufficient quantity is to see that the diet includes whole milk, butter, eggs, and fresh green vegetables. Skimmed milk, and condensed milks or milk powders made from the same, are almost useless in this respect.

2. The *water-soluble vitamine B* has its richest sources in yeast, and in the germ of wheat and other cereals; there are relatively large quantities in peas and other legumes, bran, nuts, and the glandular organs of animals; it is present in milk, egg yolk, whole wheat, fresh vegetables, meat, potatoes, and bananas; it is not found at all in highly milled cereal products like white flour or polished rice or in either animal or vegetable fats and oils. It is so widely distributed that wherever the diet is at all varied its supply is likely to be adequate enough. Where dietary restrictions are inevitable, special attention may have to be paid to meeting the need for this factor. One important means of doing so is to abandon the use of modern highly milled cereals, and to employ only whole meal in the making of bread or biscuit. Legumes or pulses can often be utilized to advantage. Under some circumstances, as, for example, with armies on active service, yeast may form a convenient and concentrated source of water-soluble vitamine. It should be kept in mind that, although milk contains this substance, it is not always particularly rich in it; so that it would be unwise to depend upon milk alone for the entire requirement.

3. The *vitamine C* is most plentifully furnished by the juices of certain fruits and vegetables, such as the orange, the cabbage, the

swede, and the tomato; it is abundant also in *germinating* seeds, whether of legumes or cereals; there is some in potatoes, meat, and milk; there is none at all in dry cereals, eggs or yeast. The extent to which the potato bulks in European and American menus doubtless gives it, in spite of its relative poverty in C, considerable practical importance as a source of this vitamine. The obvious way to ensure at all times a full supply is to make liberal use in the dietary of fresh fruits, greens, and salads. With infants it is advisable to supplement the milk ration with orange juice; when this is not available the juice of swedes or of tomatoes may be substituted. Lemon or, as it was called, "lime" juice, was long employed in the navy and merchant marine as a substitute for the fresh vegetables unprocurable on prolonged voyages in the days before refrigeration; and it still has its uses in similar circumstances.

In connection with the vitamine requirement, there are two general considerations which must not be passed unnoticed.

In the first place, whatever may be the vitamine requirement of the adult, there is no doubt that the needs in this respect of children are relatively much greater. Vitamines A and B, whatever other functions they may serve, are absolutely indispensable for the processes of growth. A deficiency of either during the growth period would have the most serious nutritional consequences. It is therefore during infancy and childhood that the supply of vitamines should be most scrupulously safeguarded. An important corollary is that the diet of pregnant and nursing women demands careful attention in this respect; for the vitamines in a mother's milk are not synthetized, like the main nutrients, in her own body, but are derived unaltered from her food.

Secondly, what has been said of the vitamine content of different foodstuffs has reference in the main only to the fresh, raw materials. Now the vitamines are relatively unstable substances, and are by no means unaffected by the processes of cooking or preservation. The most susceptible in this respect is the antiscorbutic vitamine C. It is destroyed by drying, unless this is carried out rapidly and at a low temperature; and is quickly rendered inactive by heat, so that, for example, cabbage cooked at 80° to 100° C. for one hour loses all but a trace of it. Its destruction is accelerated by an alkaline reaction and by the presence of oxygen. It follows that in their content of C salads and raw fruits are much superior to cooked vegetables;

that whenever it is necessary, as for the prevention of scurvy (see later), to guard against the destruction of this vitamine, the stew and the fireless cooker should be avoided; that most desiccated vegetables, all preserved meats, and all canned goods are devoid of antiscorbutic value;* and that, in the feeding of infants dried or pasteurized milk is inferior to raw. The last statement is not to be taken as condemning the practice of pasteurization; but it emphasizes the desirability of including a specific antiscorbutic in the diet of all artificially fed infants.

The B vitamine is not so readily destroyed as the C. It withstands desiccation, as shown by its presence in seeds. It is only slowly destroyed at 100° C. and is not affected by acids. On the other hand, it rapidly disappears at a temperature of 120° C. Consequently, while it is hardly affected in the baking of bread, it is largely destroyed in the process of canning. Canned goods as a class are practically vitamine-free, and should therefore never be allowed to bulk too largely in the diet.

The fat-soluble vitamine A appears to be like B comparatively stable to heat, since it has been stated to withstand treatment with steam for two and one-half hours; on the other hand, it appears to be rather susceptible to oxidation. On the whole the ordinary processes of cooking probably do not in this instance occasion any noteworthy loss. Desiccation also is here relatively harmless, and in the feeding of children *whole* milk powders, although deficient in vitamine C, are satisfactory sources of the fat-soluble factor. Condensed milks of the full-cream *unsweetened* type likewise retain an adequate amount; sweetened condensed milks, even when they include the cream, are in this respect inferior in value, for they must be so far diluted before use that their content of fat-soluble vitamine is liable to be reduced below the limit of safety.

B. THE SPECIFIC EFFECTS OF DIETARY DEFICIENCIES

1. Deficiency of Protein

The specific effect of an inadequate supply of protein is, in the young, retardation or arrest of growth, and in the adult an actual

*Canned tomatoes and presumably other acid fruits form an exception.

wastage of protoplasmic tissues affecting in the first place the muscles. The stunting which results from this cause alone is not accompanied by emaciation; young animals affected by it may be plump and apparently healthy although undersized; and the adult suffering from a pure protein deficiency does not necessarily lose in total body weight. A pure protein deficiency is to be sure a condition which probably does not exist outside the laboratory; but it is undoubtedly one factor in the stunted growth and chronic undernutrition so deplorably evident among the poverty-stricken inhabitants of European slums. It is a factor which, if the views of McCay are to be accepted, may have deleterious effects not only upon the individual but, when effective for generations, upon the average size, the muscularity, the endurance and the manly virtues of the entire race. Those may not have been altogether wrong, who attributed to a diminishing consumption of roast beef the widespread physical degeneracy revealed during the war by the records of British recruiting offices.

It has to be remembered in this connection that quantity is not the only factor determining the adequacy of the protein supply. An inhibition of growth may, as we have seen, be the result of merely qualitative imperfections; and even the nutrition of the adult is not exempt from the requirement that the protein consumed be of the proper nature. Our knowledge in this field is not yet so advanced that we can associate any part of the pathology of human nutrition with deficiencies of individual amino acids. The time may come when we can do so. Even now there is some reason to believe that a poor quality of protein is at least one dietary factor in the genesis of the disease pellagra; and there may be many other conditions among those now vaguely described as "malnutrition" in which it plays a unique or a subsidiary rôle.

2. **Deficiency of Energy**

A lack of sufficient energy in the diet is a step toward starvation, and its consequences are general undernutrition with emaciation and loss of weight. Starvation is not exactly a "disease;" and there are, in the adult at least, no specific pathological changes known to be associated with a simple reduction in energy

intake as such. To a certain extent indeed the condition is self-compensatory, for it has been shown experimentally[8] that, as the body diminishes in weight upon a reduced food consumption, not only does the *basal* metabolism fall to a lower level, but the energy cost of muscular activity decreases, so that on both counts the total energy requirement becomes very much less than it was. A 10 per cent reduction in weight may thus result in a 30 per cent reduction in the net requirement; and this profound change in metabolism is apparently unaccompanied by any untoward consequences, either physical or mental. The possibility of utilizing such an effect in times of stress for the conservation of food is obvious; and a gigantic experiment of this nature was in fact forced upon the people of Germany during the later years of the Great War, when the civilian ration fell as low sometimes as 1800 calories.

Of course there is a limit to physiological possibilities in this direction; and when it is passed the body must continue to lose in weight, consuming its reserves of fat and protein until death ensues.

If a *growing* animal be forced to live upon an insufficient energy intake, the food being otherwise of suitable character, it may continue to increase in length of body and limb, and even in body-weight, while through the depletion of its fat store and to a smaller extent of its muscular tissues it grows steadily thinner. Apparently it devotes in such circumstances all available reserves to the service of the "growth impulse." The tall emaciated type of underdeveloped child may sometimes be an illustration of this condition. Of course if the energy intake be altogether too low, no growth whatever will be possible, and the individual may even decline steadily in weight till he die of starvation.

3. **Deficiency of Mineral Constituents**

The mineral deficiencies practically most important, and of which the effects are most frequently encountered, are those of calcium, phosphorus, iron and possibly iodine.

Calcium is utilized mainly, and *phosphorus* largely in the formation of bone. It is therefore during infancy and childhood that

an insufficient supply of either of these elements will make itself most seriously felt. The consequences in each case appear in retarded development and imperfect ossification of the skeleton, in defective dentition, and in general debility. How far such special bone diseases as rickets and osteomalacia may be dependent upon a mere lack of calcium or phosphorus in the diet has not yet been made perfectly clear; probably other factors in any case cooperate.

Iron is required chiefly for the synthesis of hemoglobin, and a deficiency of this element in the food results in anemia. Milk is very poor in iron, and during the first year or so of its life the infant depends for blood formation largely upon the considerable store of iron with which it is furnished at birth. Thereafter it must rely upon the iron content of its food. It is clear, therefore, that for the prevention of anemia in children care must be taken to afford an ample supply of iron to (1) the mother during pregnancy and (2) the child itself after weaning. The most important sources of iron in food are eggs, meat, green vegetables, oatmeal, entire wheat flour, legumes and fruits. In all of these the iron is present in organic combination. It is doubtful whether inorganic iron can be utilized in the synthesis of hemoglobin.

Anemia may of course arise from many other causes than a simple lack of iron in the food.

Iodine is an essential constituent of the thyroid gland, the absence of which produces, or is associated with, the conditions of simple goiter and cretinism. It has therefore been supposed that in localities where these conditions are endemic, such as Switzerland and the Great Lake Basin of North America, there must be a deficiency of iodine in the food or the drink of the inhabitants. The existence of such a deficiency, and its potency as the unique cause of endemic goiter, have not yet been satisfactorily proved; but it is certainly possible to limit the prevalence of the disease by the prophylactic use of sodium iodide.[9]

4. **Deficiency of Vitamines**

When either or both of the two accessories, fat-soluble A or water-soluble B, are omitted from the diet of a young animal, its growth comes sooner or later to an end. The lack of A does not

usually make itself felt quite so promptly as that of B, for the organism appears to be capable of storing the former during periods of plenty and of utilizing its reserve gradually in times of shortage. Between total lack of these vitamines and a provision barely sufficient there is, of course, an interval in which growth may continue at a subnormal rate. It can hardly be doubted that some cases of imperfect growth or arrested development are referable rather to this cause than to a deficiency of protein or of energy, or that it is a factor which must frequently act jointly with these in the genesis of "malnutrition." This is made all the more likely when it is considered that the foodstuffs richest in vitamines are either relatively expensive, like eggs, milk, butter and meat, or, like fresh vegetables, are available only during a limited portion of the year; while the cheaper foodstuffs—carbohydrates, butter substitutes, preserved or salted meats, and canned goods generally—while capable of furnishing ample energy and therefore of satisfying the demands of appetite, are likely to contain at most a minimum of growth-promoting accessories.

It follows that the diet of the poorer classes, necessarily restricted to articles which come within the compass of their purse, is liable to contain sometimes but a meagre surplus of vitamines. The remedy, as far as it is possible under existing systems of food distribution and marketing to suggest one, is to encourage by every possible means the use of milk, fresh vegetables and fruit in the feeding of children; to recommend as butter substitutes those only which are made from animal fats, or which, if mainly of vegetable origin, contain at least 10 per cent of added butter fat; and to discourage the excessive consumption not only of preserved foods in general, but of syrups, candies, and all other vitamine-free forms of carbohydrate. The last at least of these recommendations is not applicable only to the diet of the poor; a child's appetite is not, despite natural impressions to the contrary, unlimited; and if it be permitted to satisfy any large fraction of its caloric requirement with sweetstuffs, it may secure with the remainder, even from a richly spread table, a bare sufficiency at most of other essentials.

Whether the C vitamine has any direct connection with growth is not certain.

Besides making possible in some unknown way the realization of

the growth impulse, each vitamine has, in the adult as well as in the young, other functions of still more obscure nature. There ensues accordingly in the absence of any one of them a nutritional derangement expressing itself in definite and characteristic pathological changes. Thus arise the conditions specifically known as "deficiency diseases": *xerophthalmia,* due to a deficiency of the fat-soluble A; *beriberi,* similarly related to the water-soluble B; *scurvy* and *infantile scurvy* resulting from a lack of the antiscorbutic C. To these must in all probability be added *pellagra* and *rickets,* in the etiology of which a deficiency of A is sometimes thought to be either the sole or a cooperative factor. It must not be assumed that these "avitaminoses," as they are sometimes called, are the only existing deficiency diseases. Endemic goiter is possibly, and the anemia due to lack of alimentary iron is certainly, in the same class; and the future may reveal definite morbid conditions corresponding to every conceivable type of protein or mineral deficiency.

Xerophthalmia

Xerophthalmia is an eye disease characterized by inflammation of the conjunctiva proceeding to sclerosis or even to ulceration and necrosis of the cornea, frequently complicated by superimposed infection, and resistant to all forms of local treatment. It has been most frequently encountered in children under two years of age, and is generally associated with poor appetite, general debility, and subnormal development. Outbreaks of this disease have been described in Japan during a period of food shortage, among the inmates of certain institutions for poor children in Denmark, and elsewhere.

That xerophthalmia is due to a deficiency in the fat-soluble accessory is indicated by the following points:

(1) A condition practically identical can be produced in rats by feeding them a diet which contains every known dietary essential except the vitamine A.

(2) The children affected in the various outbreaks described had in every case been fed upon diets deficient in fat, and therefore in the fat-soluble factor.

(3) The disease can be successfully treated by any change of

diet which secures a supply of that factor, e.g., by the administration of whole milk, or cod-liver oil, or (as in the Japanese cases) fish and other livers.

Beriberi

Beriberi is a disease occurring in two forms, one of which—the "dry"—is characterized by an atrophic paralysis of the legs and arms, the other—the "wet"—by a general anasarca. There are also mixed forms. The essential lesion in all is a multiple neuritis, and the disease is therefore sometimes called *polyneuritis endemica.*

Beriberi is endemic throughout the Malay Archipeligo, in the Philippines, in some parts of China and Japan, and in Brazil. It has been encountered also in Newfoundland and Labrador, in the crews of ships upon long voyages, and in asylums, prisons, and other institutions in various parts of the world.

In the Orient its incidence is associated with a too exclusive diet of polished rice, and the consumption of rice was at one time supposed to be in itself an essential etiological factor. This is not the case. When the rice used is unmilled or milled in the native way, so that the embryo and pericarp or part of them is also eaten, beriberi does not occur. It would appear, therefore, that the dietetic factor responsible for the disease is not the rice itself, but the lack of something removed from the natural grain by modern processes of milling. This view is supported, and was indeed first suggested, by the discovery that a condition essentially identical with human beriberi can be produced in pigeons or fowls by feeding them liberally but exclusively on polished rice, and that this *"polyneuritis gallinarum"* can be prevented or promptly cured by the administration of rice polishings (the refuse from the milling process) or an extract prepared from the same. The same treatment is found to be effective in the beriberi of man. The agent active in such cures, and therefore the dietary essential absent from polished rice, was at first believed to be some compound of phosphorus; but in 1911 Funk[10] isolated from rice polishings a material entirely free from phosphorus, yet able in doses of a few milligrams to restore to health a pigeon in the severest stage of polyneuritis. It was as a descriptive term for this material, and for

others like it which were assumed to be similarly responsible for protection from scurvy, rickets, and pellagra, that Funk introduced the term "vitamine." Beriberi accordingly came to be recognized as a deficiency disease caused by the lack, not of any previously known dietary constituent, but of a specific "antineuritic" or "antiberiberi vitamine."

Since beriberi is seldom encountered outside the East, it follows that the diet of other parts of the world must in general be well supplied with the antineuritic substance. A study of the matter shows that not only is this substance in fact very widely distributed among food materials, but that its distribution coincides almost or quite exactly with that of the growth substance water-soluble B. The properties of the two are also, so far as known, the same. They are therefore generally believed to be one and the same substance. Beriberi may accordingly be regarded as due to a deficiency of water-soluble B.

This view explains readily the occasional occurrence of beriberi in other than rice-eating countries. It may be expected to appear wherever or whenever the diet of the population consists too exclusively of highly milled cereals. This is believed to account for the epidemic recorded in Newfoundland and Labrador, where the diet during winter and spring consists largely of bread made from white wheat flour. It explains also the outbreaks among British troops in Mesopotamia and the Dardanelles. The rations issued to these troops consisted largely of canned goods and white bread; and it is of special interest to note that during the later stages of the siege of Kut, when the British soldiers were forced to share the coarsely ground flours of their Indian comrades, the disease disappeared.

The prophylaxis of beriberi resolves itself obviously into proper care for the supply of water-soluble B. This requires merely the application to particular circumstances of what has already been said concerning the distribution and properties of this vitamine. A useful general rule is that communities forced to live for long periods upon a seriously one-sided diet should have their cereals milled as coarsely as possible. As special sources of the antineuritic, particularly adapted for ready transport, the British Medical Research Committee[11] recommends yeast and dried eggs.

Scurvy

Scurvy is a disease of which the chief manifestations are swelling and bleeding of the gums, multiple hemorrhages occurring in almost any part of the body, anemia and progressive weakness. The hemorrhages beneath the skin and in the bones lead sometimes to ulceration or necrosis. As the body weakens the intellectual functions become depressed, and in the last stages delirium may supervene. Unless the condition is relieved by appropriate treatment it ends in death.

Scurvy has been known for centuries as the scourge of navies and of armies in the field. It has also long been known, though often forgotten, that it is caused somehow by a lack of fresh vegetables and fresh meat in the diet. Very early too it was discovered that when such articles of food were unprocurable the disease could still be prevented by the juice of lemons, oranges and other citrous fruits. In 1804 a regular issue of lemon juice or, as it was called, "lime-juice"* was made compulsory in the British navy; scurvy thereupon became a very rare disease upon His Majesty's ships, although in the eighteenth century thousands of cases had been reported every year.

The true nature of the disease was long in doubt. It has been variously attributed to a kind of ptomaine poisoning, to bacterial infection, and to lack of certain organic acids provided by the juices of fruits; but it is now almost universally believed to be, like beriberi, a vitamine deficiency. In fact it was the phenomena presented by scurvy, as observed in man and as produced experimentally in animals, that led to the conclusion that there must exist, besides the vitamines A and B, a third, C, appropriately called the antiscorbutic.

Upon this hypothesis, and bearing in mind what has already been said of the distribution and ready destructibility of the antiscorbutic, it is possible to explain satisfactorily many otherwise rather mysterious outbreaks of the disease. For instance, scurvy appeared in a Scottish camp in 1917 at a time when the men's ration included 2 oz. of swedes and a considerable amount of fresh meat, a combination which should on the face of it have afforded ample protection;

*True lime-juice has little antiscorbutic value.

but it was found that meat and vegetables were habitually cooked together as a stew for five hours, a proceeding which was bound to deprive them of all antiscorbutic potency. Cases of scurvy appearing in Glasgow, Manchester, and Newcastle in the spring of 1917 were attributable to the unusual scarcity of potatoes at that time. Again, while British troops at Kut were, as has been said, affected by beriberi, they were protected from scurvy by the large quantity of fresh meat and horseflesh included in their diet; while the Indians, deprived by their vegetarian principles of this protection, yet unable to secure fresh vegetables or fruit, suffered terribly. It has been suggested[11] that they might have been saved, had they allowed the pulses served out to them to germinate before cooking.

Infantile scurvy, or Barlow's disease, differs somewhat in its symptomatology from the scurvy of adults, and it is possible that even in its etiology some other factor is sometimes operative than a pure vitamine deficiency; yet there can be little doubt that fundamentally, both as to nature and cause, it is the same disease.

For the general principles involved in the prevention of scurvy, both in the infant and in the adult, reference may be made to the earlier discussion of the requirement of vitamine C.

Pellagra

Pellagra is characterized by (1) an erythema and dermatitis affecting specially those parts of the skin, such as the backs of the hands and the face, which are exposed to light; (2) stomatitis and diarrhea; (3) nervous disturbances of various sorts—hyperesthesias, anxiety neuroses, delirium, or dementia.

The disease is endemic in Northern Italy, Spain, Roumania, and the Southern United States, while sporadic cases have been observed in England, the Northern States, Canada, and several other parts of the world.

It is universally admitted that whatever the essential cause of pellagra may be, diet is at least one important factor in its etiology. In the regions where it is most prevalent the staple article of diet is corn, and this cereal has been frequently incriminated in one way or another as the cause of the disease. In any direct sense it has nothing to do with it, any more than rice has with beriberi. Indirectly it may have some importance; for the diets in which it

bulks largely are likely to be ill-balanced and monotonous. The diet, for instance, of the poorer classes in the Southern States consists, during the winter, very largely of corn in various shapes, molasses, and salt pork. Such a diet, it has been pointed out,[12] is deficient in at least three respects; it contains too little protein, and that of relatively low biological value, it lacks an adequate supply of fat-soluble A, and it is poor in calcium and certain other less important minerals. It is therefore considered probable by many that pellagra is a deficiency disease, possibly a syndrome resulting from the combined deficiencies just noted, possibly dependent on the lack of a special antipellagra vitamine. This general conclusion is supported by the fact that pellagra can be prevented and sometimes cured by dietary measures alone, and especially by a liberal provision of meat, milk, and eggs; while it has been experimentally produced in man by a regime limited to corn, patent flour, polished rice, pork fat, cornstarch, syrup, sweet potatoes and a small allowance of cabbage and turnip greens.[13] The deficiency theory of pellagra is, however, not yet universally accepted; some authorities still regard the faulty diet as only a contributing factor, and consider the immediate cause of the disease to be an as yet unidentified bacterium.

Rickets

Rickets is a disease of infancy of which the most characteristic features depend upon certain changes in the bones. These changes affect chiefly, though not exclusively, the long bones of the extremities and the ribs, the ends of which, at the junction between shaft and epiphysis, become thickened, while the shafts are imperfectly ossified, poor in calcium salts, and exceedingly liable to deformity or fracture. Affected children suffer also from digestive and nervous disturbances, and are usually puny, anemic and fretful.

The etiology of rickets is still uncertain. It is encountered most frequently among the poor and has been ascribed therefore to overcrowding and generally unhygienic conditions of life. It has also been attributed to dietetic factors, such as a deficiency of fat, an excess of carbohydrate, or a deficiency of calcium. Recently it has been suggested that it is caused by the lack of a vitamine. It

has been shown that a condition identified as rickets can be produced in puppies by feeding a diet consisting of separated milk, white bread, linseed oil, yeast, orange juice, and salt; and that the development of this condition can be prevented or retarded by adding to the diet certain fats, among which the animal fats were much the most effective. Meat extracts and fresh vegetables have also some inhibitory action. On the basis of such experiments it has been concluded by Mellanby,[14] that rickets is due to the lack of an "antirachitic" factor in the diet, and that this factor is probably, although not certainly, identical with the fat-soluble A. This view finds support in the well-known efficacy of cod-liver oil as a therapeutic agent in rickets; but the most recent investigations[15] tend to show that the absence of fat soluble A will not of itself produce, although its presence may sometimes be enough to prevent, the development of rickets. A deficiency of phosphorus or of calcium, or an unfavorable ratio between these two minerals in the diet, appears to play a more essential part in the pathogenesis of the disease; while lack of sunlight is perhaps a factor at least as important as any dietary deficiency.

The maladies discussed in the foregoing paragraphs are those which have long been regarded, with more or less justification, as deficiency diseases; but it should at least be mentioned that *war edema,* which was very prevalent in Central Europe during the Great War, has been thought to belong to the same category. It would not be surprising if others still were to be recognized in the future. Those now best known depend upon the absence of a single factor only; but it can hardly be doubted that combination deficiencies, as they might be called, in which two or more dietary essentials are simultaneously lacking, must sometimes arise. Pellagra and rickets are perhaps each the consequence of such a combination deficiency; and many of the nutritional disorders at present vaguely classed as "malnutrition" may be discovered to be clinical entities of similar origin.

The deficiency diseases all have a certain latent period, during which the deficiency exists but the disease has not yet become evident. The latent period of beriberi for example is eighty to ninety days, that of scurvy from four to eight months. It is almost self-evident that during the interval preceding the actual onset of

symptoms the future patient is not in a state of normal nutrition, and is likely to suffer from a general impairment of health long before the nature of his malady becomes evident. Further, there are in all probability cases in which the deficiency, although existing, is so slight, that acute and recognizable symptoms never develop at all, although the health and strength of the individual are seriously affected. It is therefore important, even in communities where no recognizable deficiency disease is prevalent, that those in charge of the public health should make it one of their duties to see that in the habitual dietary of the locality, and especially in the food of its children, all the necessary ingredients of a complete diet are made readily available to, and are regularly utilized by, the poorest of its inhabitants.

In this connection emphasis may be laid upon what McCollum[12] names specially the "protective foods." These are milk and the leafy vegetables, and they are so named because they supplement admirably the natural deficiencies of the seeds, tubers, and roots which bulk so largely as sources of our food. Seeds, tubers and roots are individually and collectively poor in calcium, deficient in fat-soluble A, and inferior in respect to the quality of their proteins. Their protein can be advantageously supplemented by meat, but meat contains itself too little of the other lacking constituents to make the combination perfect. Eggs are adapted to make good every possible deficiency except calcium. Leafy vegetables not only supply abundantly calcium and the vitamine A, but furnish proteins which supplement surprisingly well those of the roots and the seeds. Milk, of course, is so constituted as to furnish every requirement of animal nutrition, including protein of at least equal quality with that of meat. The importance to public health of safeguarding and cheapening the milk supply cannot therefore be exaggerated.

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CHAPTER XVII

DOMESTIC AND COMMUNITY SANITATION

BY PETER GILLESPIE, C.E.

HOUSE PLUMBING

The Soil Pipe

Where the water carriage system is utilized, the central feature of the plumbing installation is the soil pipe. This pipe extends from its outlet through the roof to the basement where it connects with the house drain. It is usually of cast iron, not less than four inches in diameter, with leaded bell and spigot joints. Its junction with the house drain should be made preferably with a wye and an eighth bend and a clean-out should always be provided. The house drain from this junction to a point just beyond the basement wall should preferably be of cast iron although vitrified tile with cemented joints is sometimes used. Its minimum gradient is one-quarter inch to the foot. Because of the formation of hoar frost in the bore of that portion of the soil pipe exposed to the weather, it is a common practice to increase the size of the main stack in the vicinity of the roof line. An increaser just below the roof and a roof flange just above it are the specials usually employed. The roof pipe should extend two feet above the roof.

The soil pipe receives the waste from the various fixtures—water closet, bath tub, laundry trays, etc.,—connection being made preferably by wye branches. If this be impossible, tee-wyes are used, since these fittings facilitate the natural flow of the water much better than do tees.

Traps

To prevent the escape of sewer gas into the dwelling, each fixture is trapped. In each trap a water seal of two inches, or thereabouts, constitutes the barrier between the interior of the soil pipe and the atmosphere of the rooms. The simplest and most common type of trap is the so-called S-trap, often made by bending lead pipe into the form of the letter S. The P-trap, or half S, is a modi-

fication of the S-trap. The drum trap consists of an upright 4-inch metallic cylinder, the inlet usually being near the bottom and the outlet near the top on the opposite side. Obviously because of the greater section of the drum trap in relation to the waste pipe as compared with the S-trap, the scouring and self-cleansing quality is less pronounced.

The water seal in a trap may be destroyed by evaporation through long periods of disuse, by leakage, by capillary action and by siphonage if the traps be not properly vented. Pieces of fabric, cotton waste and such like sometimes lodge in a trap with one end

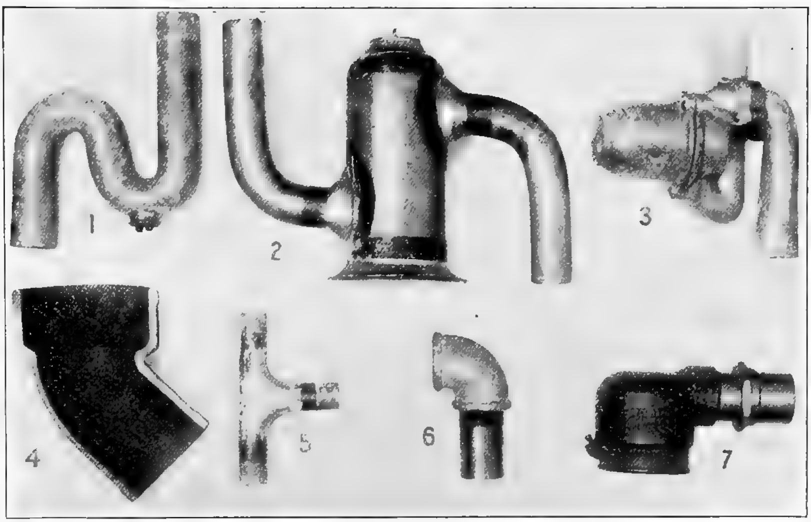

Fig. 70.—Various plumbing fittings. *1*, an S trap; *2*, a drum trap; *3*, a non-siphoning trap; *4*, section of a cast iron eighth bend; *5* a "wiped" joint; *6*, an ell and brass solder nipple; *7*, the McClellan air inlet for traps.

dipping into the water seal and the other extending over into the outlet. By capillary action, the water in the trap is gradually removed and the seal is destroyed. The most common cause of seal destruction in traps not vented against it, is siphonage. Water descending in a waste pipe full bore falls with a constantly increasing velocity and tends to break into cylinders with a rarefied atmosphere separating successive sections. Any trap connected to a waste pipe or a soil pipe in which this condition obtains will have its water seal partially or wholly removed because the pressure exerted

by the atmosphere in the room exceeds that existing in the pipe to which the trap is connected. Stated in language less technical, the water content of the trap is sucked out by the rapidly descending water from either the fixture itself or from some fixture higher up.

To prevent this, the practice of venting is regularly resorted to. An alternative is to utilize traps of the so-called nonsiphoning type.

Venting

It will be seen that if a trap be opened at or near its crown or highest point so that air may freely enter there when the partial vacuum exists as explained above, the siphonage of the water seal will be prevented. Stripped of all detail, this is the principle of trap venting, a practice almost universally required in present day plumbing regulations. The common practice is to provide a main vent pipe smaller than and parallel to the soil pipe joining the latter usually below its junction with the lowest fixture and rejoining it again above the highest. To this main vent pipe, the various trap vents are connected. The inclusion of this feature in the plumbing arrangements of a house will eliminate entirely the troubles due to siphonage, adding, however, perhaps one-third to the original cost. It should be remembered notwithstanding, that there is a great tendency for grease, fiber, etc., to accumulate at the junction of the vent and the trap, which accumulation, unknown to the user, may in the course of time render the vent entirely inoperative.

Nonsiphoning Traps

To avoid the trouble and cost of providing an adequate venting system, many forms of so-called non-siphoning traps have been invented and put on the market. Strictly speaking, there is no trap that is non-siphoning, although there are many types out of which it is almost impossible by suction to remove the entire water content. The drum trap is one of these. This is largely because the cross-section of the trap is so much larger than that of the waste pipe connected to it. If through the accumulation of grease and filth inside the drum, an open passage of small bore, extends through the trap from inlet to outlet, the advantage possessed by the drum trap over others of constant section largely disappears. In addition

there are baffled traps of special construction such, for example, as the "Sanitas," sometimes employed where the use of unvented traps is permitted. This practice, while prohibited in most of our city plumbing codes is, because of its more moderate cost, often employed in smaller towns and rural communities. Every trap should be provided with a clean-out so that obstructions which choke the passages may without much trouble be removed.

Connections

Joints in cast iron soil pipe are made by pouring molten lead into the bell around the spigot, passage into the interior being prevented by a rope of oakum placed therein in advance of the pouring of the lead. The lead when solid is caulked even with the top of the hub. Lead to lead connections are made by "wiping" or soldering. Lead to brass connections are also made by soldering so that when lead waste pipes discharge into cast iron soil pipes, the connection is made by the use of a brass ferrule or thimble to which the lead pipe is wiped. This thimble is then caulked into the hub of a soil pipe fitting in the same manner as a cast iron spigot.

Durham System

In the "Durham" system, so-called, soil, waste and vent pipes are of galvanized wrought iron; the fittings (ells, wyes, tees, etc.) are of cast iron and all joints are screwed instead of caulked as is done with cast iron pipe. Fittings through which waste is to be conveyed should have "recessed" hubs so that the bore of the pipe is in perfect alignment with the bore of the fitting and that there may be no shoulders to arrest the solids present in the waste. In order to provide a suitable gradient on horizontal runs of pipe, the fittings are regularly "pitched," for example, all nominal quarter turns are a trifle less than 90 degrees. The chief use of the Durham system is in tall city buildings.

The Main Trap

The function of the main trap is to exclude sewer air from the plumbing system. It is placed on the house drain either just inside or just outside the basement wall. If all fixtures are properly

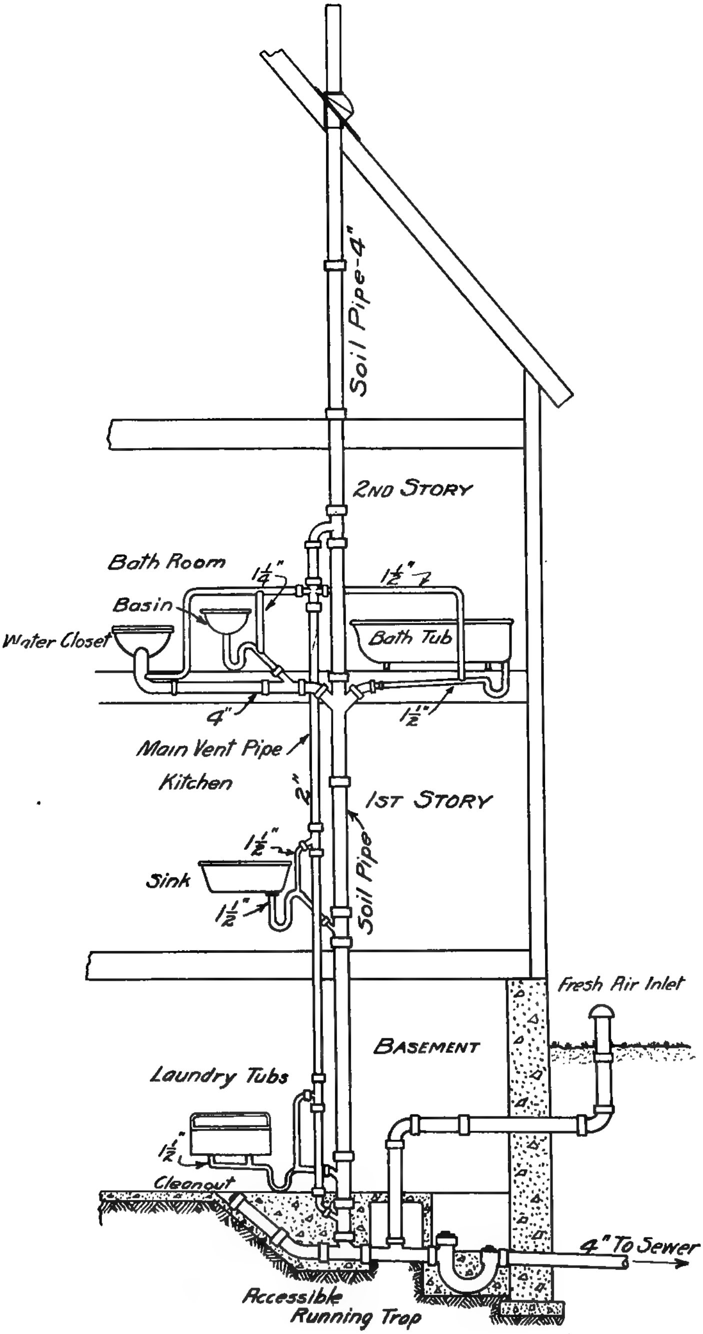

Fig. 71.—System of vented plumbing for dwelling house.

trapped, the passage of sewer air into the dwelling would seem to be pretty well guarded against and the necessity of the main trap would not at first sight appear. It should be remembered that although a plumbing system may be perfectly tight at the time it is installed, defects due to inadequate support, to settlement and to expansion and contraction consequent on temperature changes may develop in the course of years of service. In such cases the main trap constitutes a very important second line of defence as indeed it is also whenever alterations or repairs in the soil or waste pipes are in progress. The public sewer in an urban community is a filthy place receiving the disease laden wastes from many sources and the exclusion from the plumbing system of the dwelling of the effluvia arising therefrom would seem to be a reasonable argument for the retention of the main trap although many authorities have advocated its discontinuance. In cases where the house drain discharges into a residential septic tank, the gas in the sewer will generally be less objectionable and the main trap and fresh air inlet may with impunity be omitted. The soil pipe then becomes a ventilator to the septic tank by which the gases emitted therefrom are conveyed through the roof of the dwelling to the atmosphere above all window openings.

Fresh Air Inlet

Whenever the main trap is employed, the fresh air inlet is a necessary accessory. Through it, fresh air is drawn in near the ground, passes up through the soil pipe and out through the roof pipe insuring at all times a reasonably fresh atmosphere within the plumbing system. The fresh air inlet must connect with the house drain on the house side, not the street side of the main trap. While the function of the fresh air inlet is normally to act as an inlet it will sometimes act as an outlet for the gases contained in the soil pipe. This occurs when a fixture is discharging a volume of waste sufficient to fill or nearly fill the soil pipe full bore. The column of falling water will force the gases in the soil pipe ahead of itself and momentarily only the fresh air inlet is a means for their escape. For this reason the fresh air inlet is not placed closer to any window than ten or fifteen feet. If, as indicated above, the main trap be omitted, the fresh air inlet is dispensed with also.

Whenever employed it should be accessible for cleaning and repairs and should be provided with one, and preferably, with two cleanouts.

Laundry Tubs

Laundry tubs are made of enameled cast iron, slate, soapstone and Portland cement concrete. They are usually in sets of two or more but single tubs for special locations are also available for the householder. Cracks which sometimes develop in tubs of concrete,

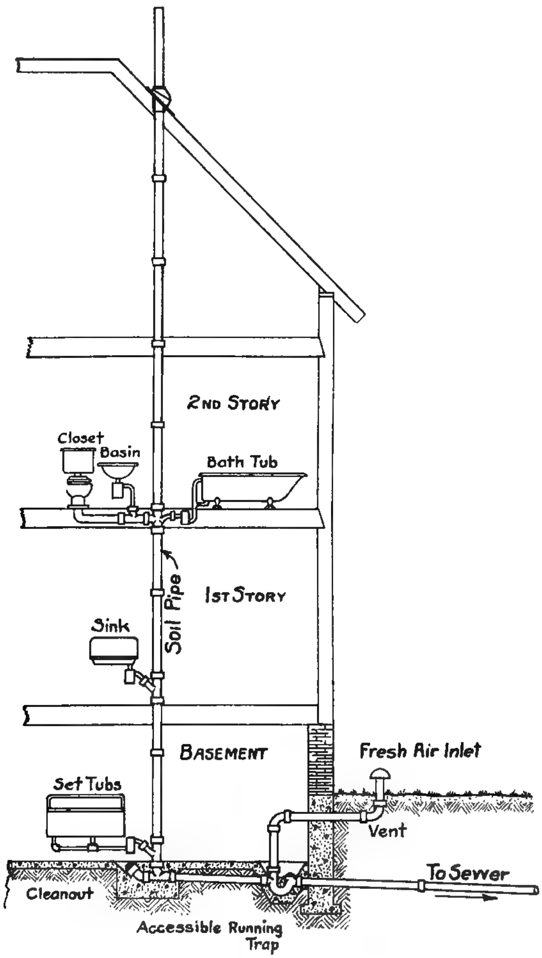

Fig. 72.—System of unvented plumbing for dwelling house.

slate or soapstone may be satisfactorily repaired by the use of a paste made from oxide of lead and glycerine. Needless to say, these fixtures should be installed only where the light is adequate.

The Kitchen Sink

The kitchen sink should be of enameled cast iron, the outlet provided with a removable strainer to prevent refuse from entering the trap below. It should be provided on one side with a sloping drain board, grooved to assist the draining of utensils and should have a high enameled back to protect the wall. A grease trap beneath to separate the fat from wash water emptied into the sink is a good feature if properly and regularly attended to, but not otherwise and in view of its almost general neglect, is, perhaps, just as well omitted from the plumbing of the ordinary dwelling house. Melted fats coming in contact with the cold waste pipe from the sink are very likely to congeal and adhere to its inside surface. To remove this, a hot solution of ammonia or washing soda, may be used from time to time. A solution of chloride of lime is an excellent remover of stains on the enamel.

The Hot Water Boiler

The hot water boiler is merely a storage for hot water supplied usually from the kitchen range. The water front receives cold water from the bottom of the boiler and supplies heated water to the boiler again at a higher level. The higher this level, the less is the hot water diluted with the cold and the more quickly is hot water available for use after heating has begun. When hot water is drawn off for any purpose, an equivalent volume of cold is supplied from the service pipes to the boiler. To prevent the incoming cold water mixing with the hot water already there, the supply is introduced at the bottom of the boiler instead of at the top, through an open ended pipe within the boiler extending from the top to within a few inches of the bottom.

Water Closets

A water closet should be self-cleansing, not wasteful in the use of water, comparatively noiseless in operation, should have a self-

contained trap of adequate seal and should have as few moving parts as possible. Of those at present in the market, the rim flushing siphon and the rim flushing siphon jet are to be preferred over all others. In these types, all surfaces are thoroughly flushed and through the siphon all filth is removed leaving the seal as at first. (Fig. 73.)

Bath Tubs

Probably the most popular type of bath tub, having regard to cost as well as quality, is the cast iron enameled, with a wide roll rim. The all-porcelain tubs are quite expensive, while the enamel-painted is likely to give indifferent service owing to the wearing away of the paint. To facilitate cleaning, a drum trap with screwed

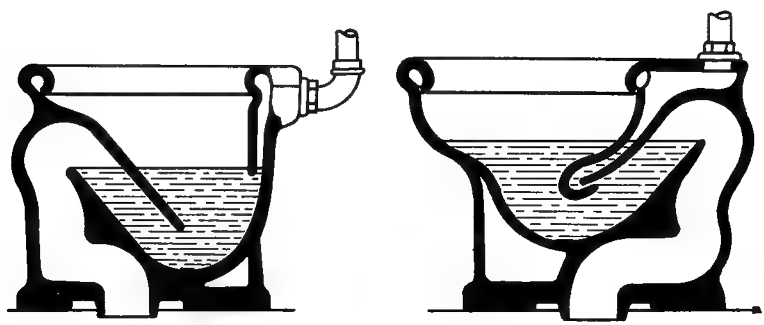

Fig. 73.—Siphon and siphon jet closets.

top flush with the floor is commonly used. The supply inlet to a bath tub or wash bowl should not be lower than the water level in the tub or bowl when full, otherwise a lowering of the pressure in the water system may cause the contents to siphon over and to appear at the water faucets in the rooms below. This lowering of pressure may result from the simultaneous opening of two or three water faucets on a lower floor and the consequent reduction of the water pressure in the upper story piping until it is less than atmospheric.

Needless to say, all bathrooms should be well lighted and ventilated and should have floor and walls which are nonabsorbent and which permit of easy cleaning. This is the first essential for the creation of wholesome and sanitary conditions.

Costs

The plumbing of a small dwelling house to include cast iron enameled bath, wash bowl, rim flushing siphon toilet, kitchen sink, cement laundry tubs and hot water boiler with all fixtures vented as shown in Fig. 71 will cost from $400 to $600 according to the locality.

SANITATION OF THE ISOLATED RESIDENCE

Methods

There are two methods of disposing of human filth—the wet and the dry. The former is used where closets are supplied with water for flushing purposes as in cities and towns and in some rural communities. The latter must be resorted to where the convenience of running water is not to be had and is employed and will continue to be employed at the great majority of rural residences. In any case the sanitary disposal of human filth is a matter of the very first importance so far as the health of the family is concerned.

The Privy

At many rural homes there is an open-backed outside privy. The filth is discharged directly onto the ground, exposed to sight, air and insects. A heavy rain may easily wash the filth over the garden and maybe into an adjacent well from which the domestic supply is drawn. The children with their pets and toys playing in the vicinity easily and often get the pollution into their mouths. Flies having ready access to the fecal matter breed in it, get their bodies smeared with it and crawl over the food and the mouths of sleeping children. Under such conditions, the prevalence of dysentery, tuberculosis, and typhoid fever need occasion no surprise.

Since it is not likely that the outdoor privy in our rural communities will be abandoned for many years to come, it becomes necessary that it be made as sanitary as possible so that the menace referred to above will be removed. Such a structure should not offend the senses of sight or smell, it should be conveniently reached from the dwelling, its usefulness should not be impaired by freezing weather, it should completely preclude the transmission of disease

germs from excreta to human beings, and above all it should be so constructed that the care and attention necessary to its successful operation are of the simplest possible character and involve the fewest possible objectionable tasks. The privy at its best is an inelegant thing and for it there are modern substitutes which have few of its objectionable features. But either the cost of the substitutes in the general case is too great or they demand a kind and a regularity of attention which is simply unprocurable in rural communities that it is quite idle to suggest their adoption. The privy with the impervious concrete vault beneath intended to be cleaned periodically by shovelling or bailing is not to be recommended. The operation of cleaning is so offensive; and the danger that the filth may be smeared on the ground, on vehicles and on utensils and clothing is so great that its one advantage, the non-pollution of the soil, does not compensate for its shortcomings. Moreover, the cost of construction is moderately high. Another device open to similar objections is the privy beneath which is a water-tight liquefying vault filled with water, and arranged with an overflow into a vessel which from time to time is to be removed and emptied. In the first place, the vault is fairly expensive to construct; in the second, odors are likely to be troublesome; in the third, a vessel containing filthy liquid is much more difficult to handle than one whose contents are solid, and in the fourth, being out of sight, it is almost sure to be neglected.

For the common farm house, where the well is on a line of drainage different from the privy and therefore not subject to pollution from it, the least expensive device is an excavation four feet square and five feet deep which is lined with vertical inch lumber nailed to horizontal 2×4 inch braces to prevent the earth caving in. Over this a vermin-proof, well-ventilated, wire-screened privy with self closing door is constructed. If the site is on slightly elevated ground, so much the better as this will facilitate surface drainage away from the building. Under no conditions should the vault be open to the atmosphere from the outside and flies should be completely excluded from above as well as from below the floor. The use of dry earth or wood ashes by each occupant after use will greatly diminish offensive odors and a container for one of these should be provided. Occasional applications of chloride of lime or of a coal-

tar disinfectant will further safeguard against objectionable smells. Such a vault in dry sandy soil would serve a family of five persons for six years, after which either a new site should be selected and a new vault excavated, or the old one cleaned out.

A somewhat better type of outhouse, in that it does not pollute the soil, is one provided with watertight impervious receptacles which are regularly removed and emptied. The building itself is, of course, insect tight and weatherproof but well ventilated. The containers are of metal with outside handles and are placed and removed from the rear of the building by the opening of a hinged falldoor. (Figs. 74 and 75.) Their overall depth should be ½ inch less than the height in the clear under the seat. When full, they are emptied into trenches which are immediately back-filled. To insure their proper placing after emptying, a V-shaped stop is nailed to the floor and the vessel is shoved up tight against this. A container for dry earth or ashes is a very important part of the equipment. This type of privy, if properly cared for is sanitary and odors are reduced to a minimum. There is no danger of polluting a well since the soil is not contaminated. In cold weather, however, the privy should be protected against frost, or a nonfreezing liquid should be supplied to the pails. Emptying will othewise be attended with difficulties.

It is believed that either of the privies described above can with proper care be made to meet all reasonable sanitary requirements. Each is simple and inexpensive to construct. Neither requires much time or attention to maintain it in condition nor much objectionable handling of excreta. Of the two, the first can be employed only where there is absolute certainty that pollution of the soil cannot possibly lead to contamination of the water supply.

Water Carriage System

Where running water, the indoor closet and bathroom have been provided, a different method of treating the household wastes must be devised. The problem in this case is complicated by the fact that the volume of water in household sewage is probably 400 times greater than the solids contained therein. A common and obvious solution is to discharge directly into the nearest water course. In some cases this is permissible. Indeed, dilution either as a sole or as

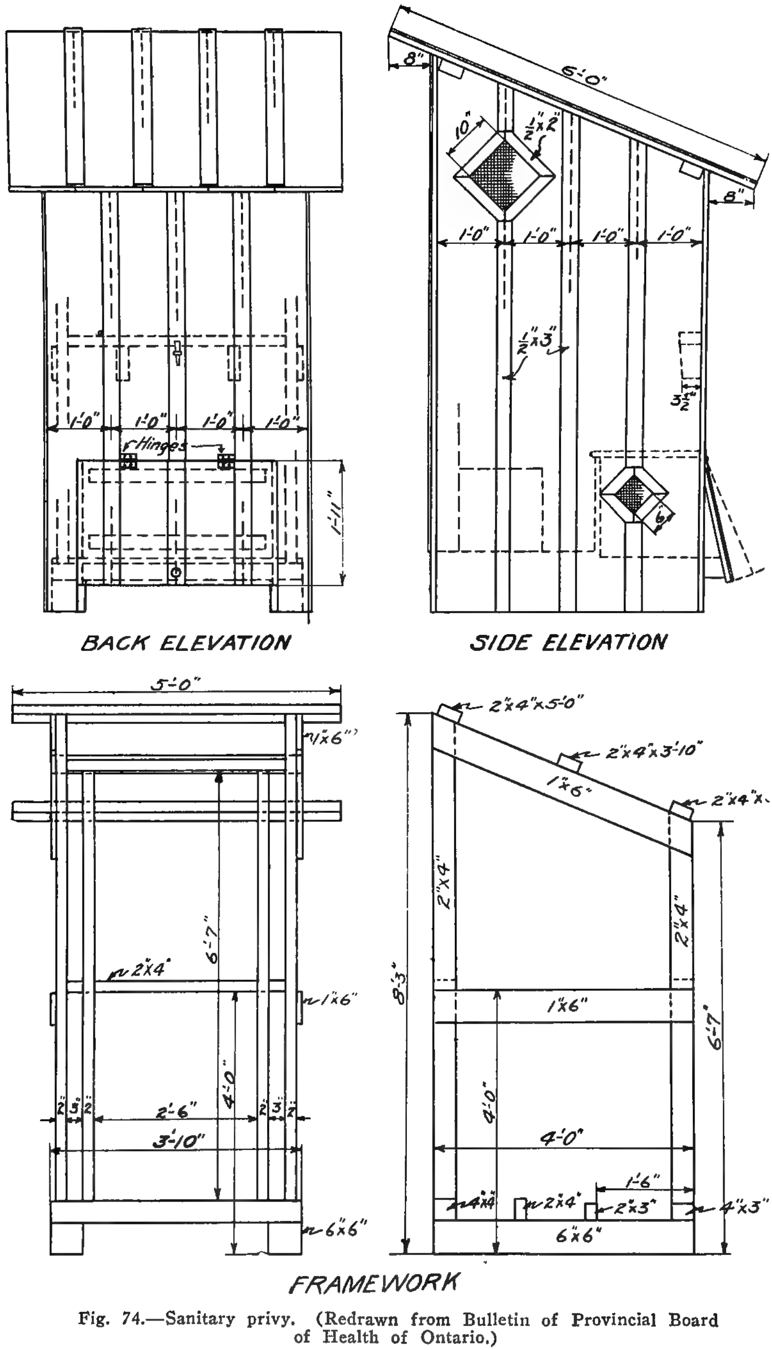

Fig. 74.—Sanitary privy. (Redrawn from Bulletin of Provincial Board of Health of Ontario.)

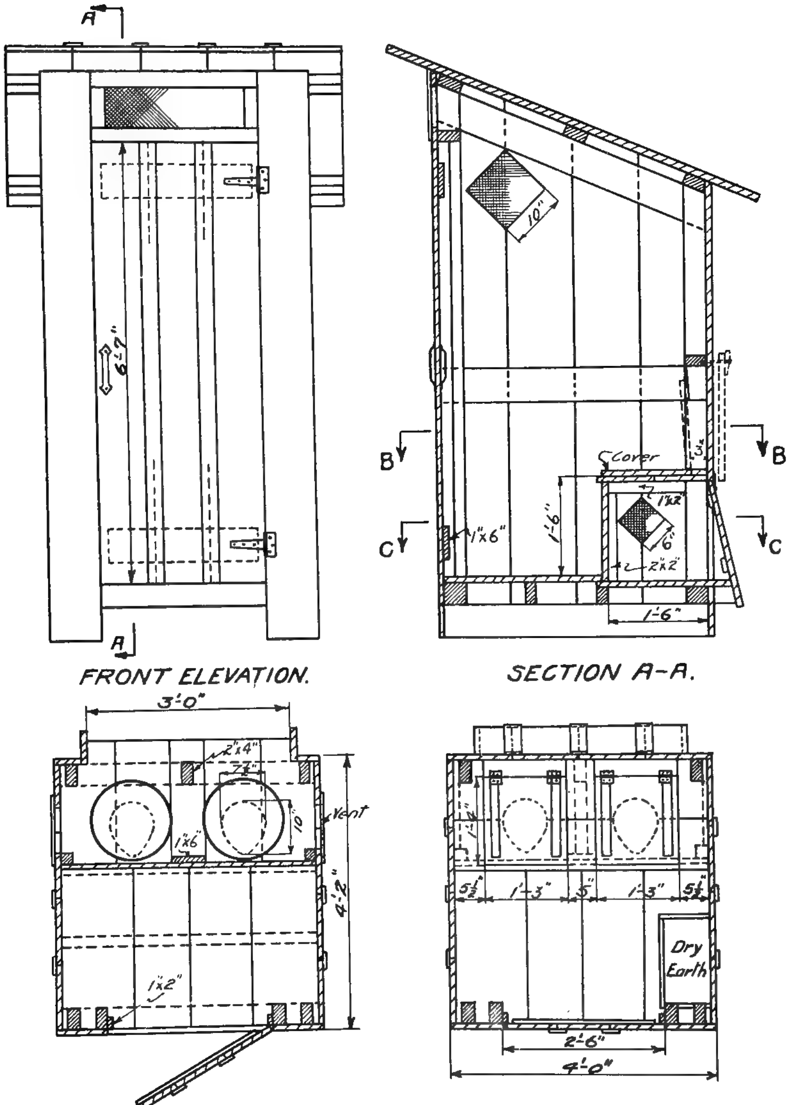

Fig. 75.—Sanitary privy. (Redrawn from Bulletin of Provincial Board of Health of Ontario.)

a finishing process is very generally employed. But the growing appreciation of the necessity of safe water supplies, the wish to avoid the creation of nuisances offensive to sight and smell, an increasing realization of the responsibilities incident to community life and the fact that the beneficent stream is often not available, have led to the development of alternative methods. Indeed the alternative method is the usual one in the case of the rural residence. As in a previous discussion, a distinction must be made between those cases where soil pollution may be permissible and where it must be avoided. On a farm where only one dwelling is found, it may easily happen that a polluted soil remote from the dwelling and sufficiently far from a well will involve no danger whereas the same condition would not exist in a village where dwellings are more closely grouped. In the former case the much condemned leaching cesspool would be tolerated; in the latter it would not.

Cesspool

The leaching cesspool is really an excavated pit walled in by open stonework so that the liquid content of the sewage is free to enter the soil which should be sandy and porous. Sooner or later the solids fill the cesspool and a new one must be constructed. The depth is usually such that practically no oxidation takes place in the surrounding soil and as putrefactive and anaerobic changes are very offensive, pollution of the soil is inevitable and of adjacent wells very probable. If the soil be impervious or if the vault be lined with watertight masonry, the chamber soon fills with liquor which putrefies and overflows on the surface if no other outlet be provided. (Fig. 76.) To forestall this, open jointed tiling is sometimes laid near the surface radiating from the outlet and this is surrounded by porous soil, gravel or cinders. This provides a partially aerated absorption area in which limited oxidation may take place. But since the outflow is continuous, the first portion of the area gets the major portion of the liquor and the rest scarcely any. Aeration is in consequence much hampered, for soil filtration in order to be effective must be intermittent. Pollution of the soil therefore to a greater or less extent results in this type also.

Subsurface Irrigation

The defects in the various types of cesspool have led to the development of the subsurface irrigation method sometimes spoken of as the Waring system since it was first employed by the late Col. George E. Waring for his residence in Newport, R. I., some fifty odd

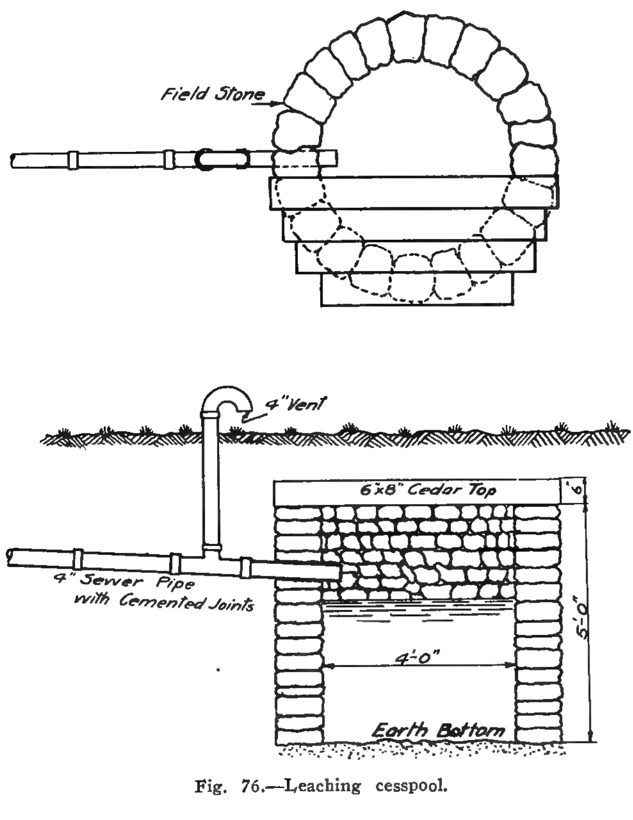

Fig. 76.—Leaching cesspool.

years ago. A two-chambered septic tank with an automatic siphon in the second of the two chambers is constructed. In the first chamber the solids partially settle to the bottom and a floating scum forms on the surface. The outlet is usually submerged so that only the relatively clear liquor lying between the bottom sludge and the surface scum may pass to the siphon chamber. In it there takes place an hydrolysis or chemical breaking down of the organic solids

through their combination with the hydrogen and oxygen of the water. In the second chamber, the settled sewage is held back until a predetermined quantity has accumulated. This is then all discharged at one flush through open jointed tiles laid one foot beneath the surface in the absorption area which should be a sandy soil and preferably unshaded by trees or other heavy vegetation. Thus is insured something approaching a uniform distribution of

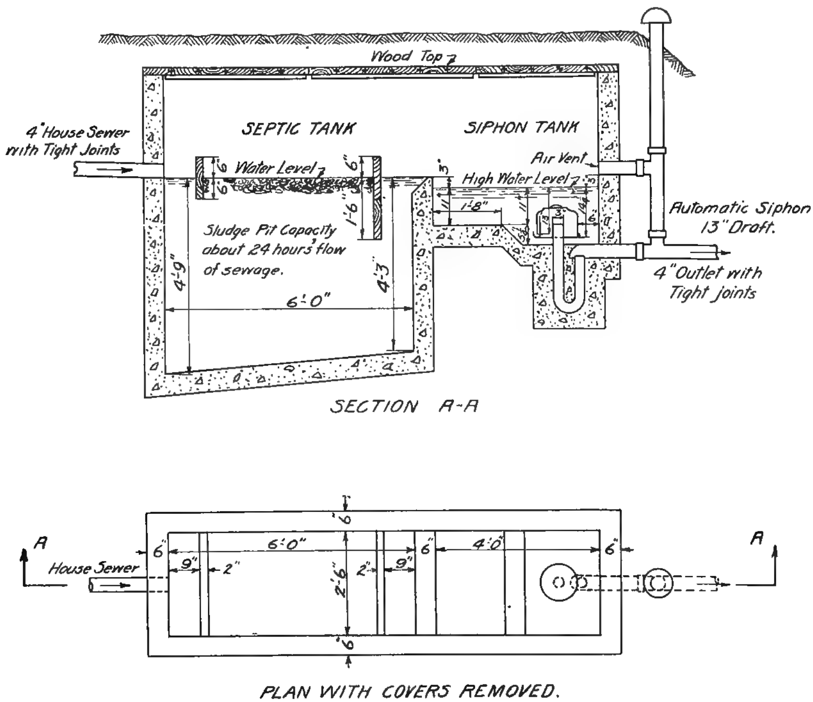

Fig. 77.—Septic tank for residence.

liquor and between successive doses there is afforded an opportunity for aeration of the soil so necessary to satisfactory nitrification. The net result is that there has been enlisted the combined purifying resources of a large area of surface soil and an ample supply of atmospheric oxygen together with an intermittency in application which makes the process capable of almost indefinite repetition.

Care should be taken to have the capacity of the tiles only

slightly less than the contents of the siphon chamber. Moreover this tile should be laid with joints covered in such a way that the backfilled earth may not enter the drains and impede the flow of the sewage therein. It is advisable to divide the subsurface tiles

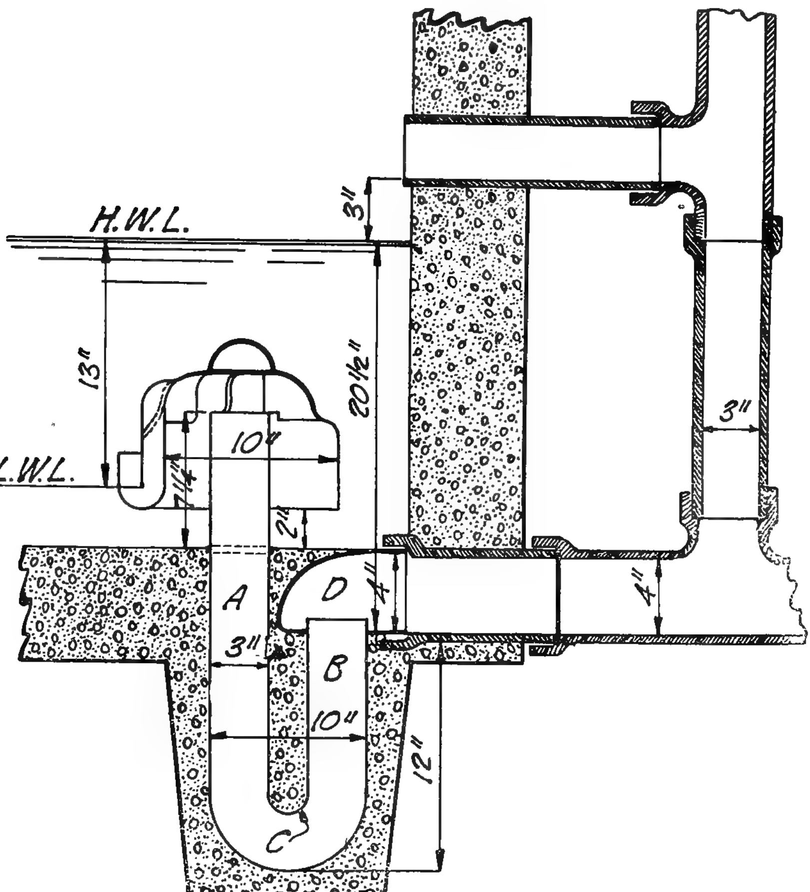

Fig. 78.—Standard 3-inch Miller siphon.

into two sections and to provide a diverting device so that the liquor is sent during alternate weeks into the two sections. The resting period improves the purification and prevents the choking of the soil by the suspended matter in the liquor of which there is always more or less. These tiles may be laid on a gradient of ⅛ inch per

foot to facilitate the flow. If the liquor comes to the surface over the absorption area, it is to be regarded as evidence that the porosity of the soil is inadequate. Additional tiling or the lowering of ground water by under draining would be the remedy. The danger of the absorption area freezing is not great in winters of moderate severity especially in porous soils since the sewage liquor is ordinarily 15° F. above freezing when discharged into the drains. Cleaning of the septic tank occasionally and the relaying of subsurface tiles at infrequent intervals are necessary, but no rule as to this can be given. Good practice favors the following rules for residential tanks and drains: Provide 15 cubic feet per person below the flow line in the first chamber; provide 2.0 cubic feet per person between high and low water levels in the siphon chamber; provide 35 lineal feet of 3-inch agricultural tile per person for subsurface drains. With a water consumption of 25 gallons per person per day, the siphon will discharge twice in 24 hours.

It is a great convenience in a residence or an institution to have laundry and water closet facilities in the basement and to be able to drain the basement floor into the house sewer. This necessitates laying the latter sufficiently below the basement floor to permit of the installation of these conveniences. The invert of the house sewer at its junction with the vertical soil pipe will lie about 15 inches below the basement floor and the plan for sewage treatment will have to take this into account. Where the fall is ample the solution is easy but where the ground adjacent to the building is very flat, difficulties occur. If the septic tank is to lie 100 feet from the vertical soil pipe and the subsurface drainage area 60 feet farther on; if the house sewer is to have a fall of $\frac{1}{4}$ inch per foot and if the inverts of the subsurface drains are to be 12 inches below the surface of the soil as is usually recommended, the least difference in elevation between the basement floor and the subsurface drainage area will be found as follows:

Difference in elevation between basement floor and invert to house sewer	1 ft.	3 in.
Drop in 100 ft. of sewer, 1/4 in. per foot	2 "	1 "
Difference in water level in tank and H. W. mark in siphon chamber		2 "
Drop from H. W. mark in siphon chamber to invert of siphon	1 "	8½ "
Drop in 60 ft. of sewer, 1/4 in. per foot,	1 "	3 "
Total	6 "	5½ "

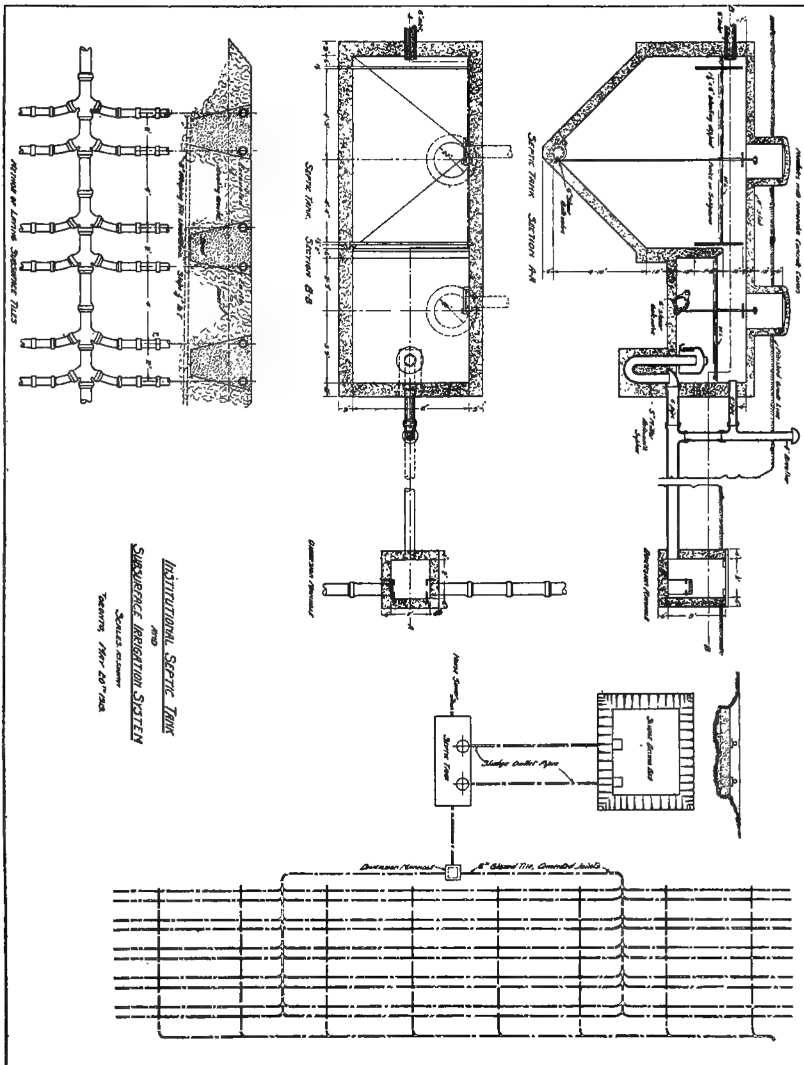

Fig. 79.—Septic tank and subsurface irrigation for an institution.

From this total, one foot is to be subtracted owing to the fact that the subsurface drains are 12 inches beneath the surface. For the conditions assumed, it is therefore necessary that the drainage area be 5 feet 5½ inches below the basement floor. The gradients for the house sewer and the effluent line could be lessened slightly, if necessary, thus reducing the figure given. In flat districts, therefore, the building site should, if possible, be on the highest available ground and the basement excavation should be shallow. In some cases it may be necessary to construct the plant partially above ground where the necessary fall cannot be obtained otherwise. Sanitary conveniences in the basement would, of course, have to be sacrificed if this course were adopted.

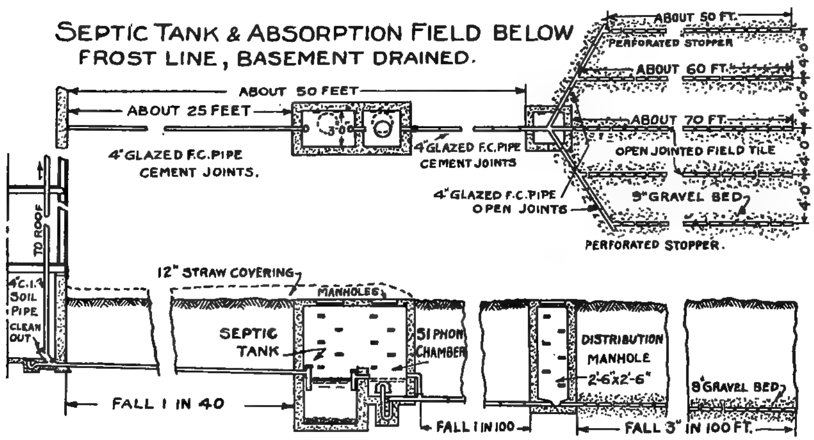

Fig. 80.—Absorption field for tank effluent below frost line. (Redrawn from Bulletin of Bureau of Public Health, Saskatchewan.)

Fig. 80 shows a method of utilizing the absorptive capacity of soils several feet beneath the surface which appears in some cases to have given good satisfaction in the Province of Saskatchewan where the winters are usually severe. These absorption fields must be constructed in soil that will absorb water. A sand or gravel which is not water-bearing would seem to be necessary. The distribution tiles are laid in this material at a depth of seven feet or sufficiently low to prevent their freezing. In other respects, the system is analogous to the familiar method of subsurface irrigation. It will be obvious that if at any season, the soil becomes

charged with water, the entire installation will be put out of service until the water subsides. There will, of course, be pollution of the medium into which the effluent is discharged since aeration is possible to only a very limited extent.

Chemical Closets

Chemical closets are closed watertight receptacles for human excreta to which is added a disinfecting reagent which may in addition have a liquefying action on the contents. There are two general types. In one an alkaline emulsion of coal tar or similar product is the means of disinfection and deodorization; in the other a strong caustic solution is the principal reagent employed. The chemical closet must not receive the flushings of a water closet, since its capacity is ordinarily limited to a few cubic feet. Moreover in the removal of filth from the walls of the closet, necessary at times under all conditions, water must not be used in any considerable quantity. From time to time the contents are drained out if the fall is sufficient, or pumped out if it is not, and disposed of by burial or otherwise. The chemical closet is sometimes installed in a room in a dwelling in which case good ventilation is indispensable. The essentials in operation appear to be the employment of such reagents in the receptacle as will destroy pathogenic bacteria and such careful handling of the contents in their final disposition that even though the disinfecting process may have been incomplete, no menace to health may result therefrom. The cost of the equipment, exclusive of installation, will be in the neighborhood of $125. In the cost of upkeep, the outlay for chemical must not be overlooked.

SEWERS AND SEWERAGE

Separate and Combined Systems

Sewage is the water supply of a community after it has been used. It is known as domestic if its source be the abodes of men, and industrial if it be the liquid waste from manufacturing processes. Storm water is a term applied to water falling on urban or other areas in times of storm and for the conveyance of which

drainage facilities have to be provided. Sewage and storm water are usually carried underground in pipes or drains called sewers, whose location, size, gradients, depths and carrying capacity are determined by a variety of circumstances of which population, and topography are among the most important. If one set of pipes be provided for domestic and industrial sewage and another set for storm water, the community is said to be sewered on the *separate system;* if, on the other hand, all kinds of sewage and storm water are carried in one set of drains, the community is sewered on the *combined system.* If the combined system be adopted the sizes will be determined by the volume of storm water to be transported as this in general is many times greater than the volume of the so-called sanitary sewage. Obviously the cost of two lines of sewers will exceed the cost of one. The excess of the cost of separate sewers over that of combined sewers serving the same area is found to be from 33 to 50 per cent. One argument among many in favor of separate sewers is that where sewage must be treated, the purification plant can be designed to take care of the normal dry weather flow only, whereas if combined sewers be in use some provision must be made for excessive volumes of sewage in times of storm. This statement also applies to sewage pumps when these for any reason are required.

Sewer Appurtenances

Inspection manholes built of concrete or brick masonry and extending from the sewer to the surface of the ground are placed at street intersections, at changes of gradient and alignment, and between these points also if the distances separating them exceed 500 or 600 feet. These permit of the inspection of the barrel of the sewer, the location of trouble, and the removal of obstructions. *Siphons,* so-called, are U-shaped pressure conduits carrying sewage beneath streams or across valleys where it is not possible to maintain a uniform gradient. Frequently they are built of cast iron and the bore is such that self-cleansing velocities as far as possible are maintained therein. If moderately high velocities are assured, the choking of the siphon with silt is provided against. *Storm water inlets* to storm sewers and combined sewers are provided at regular intervals along the street gutters. Rain water from the street enters

the sewer through these inlets. They are usually provided with catch basins in which much of the heavier-than-water matters contained in the street wash are arrested. These should be cleaned out at regular intervals. *Intercepting sewers* are constructed to receive the flow from a series of sewers previously built, the point of discharge of which it is necessary to change. These are often designed to carry the normal dry-weather flow or perhaps something greater than this. The contributing sewers are then provided at their junctions with the intercepting sewer with storm water overflows so that a portion of their flow in excess of a predetermined maximum is not intercepted, but passes direct to its old point of discharge. *Storm water overflows* are usually weirs with crest at such a height that they do not come into operation except in times of heavy flow. A *subdrain* is a drain constructed beneath a sewer and parallel to it, its purpose being to intercept ground water which might otherwise enter the sewer.

Automatic flush tanks are sometimes employed to accomplish the cleansing of sewers by discharging into them periodically large quantities of city water. The discharge is controlled by an automatic siphon, which holds back the inflow until sufficient has accumulated to wash away the stranded solids from the sewer.

Carrying Capacity of Sewers

The law which governs the velocity of water in sewers of similar interior surface flowing full or half full not under pressure, is approximately as follows: The mean velocity of flow is directly proportional to the square root of the slope and to the square root of the "hydraulic radius" or "mean depth." This latter function is simply the area of the cross-section of the stream divided by the wetted perimeter. If the section of a pipe be symmetrical about a horizontal axis, the hydraulic radius is the same when half full as when full and in accordance with the law as stated above the velocities will be the same also. Circular and square sections are examples of this. The discharge of a pipe running full is the product of the mean velocity and the area of cross-section. Table LIX adapted from Folwell will serve to illustrate the law.

An examination of the table shows that for any given gradient or slope, the velocity is much greater in large sewers than in small and

TABLE LIX

VELOCITY AND DISCHARGE IN TILE SEWERS RUNNING FULL

V = mean velocity in feet per second
Q = discharge in cubic feet per second

SLOPE IN FEET PER 100	4-INCH		6-INCH		8-INCH		10-INCH		12-INCH	
	V	Q	V	Q	V	Q	V	Q	V	Q
0.1							1.17	.64	1.35	1.06
0.2					1.40	.49	1.67	.91	1.91	1.51
0.4			1.59	.31	2.00	.70	2.38	1.30	2.74	2.16
0.6	1.38	.12	1.95	.38	2.45	.86	2.92	1.59	3.35	2.64
0.8	1.61	.14	2.25	.44	2.83	.99	3.37	1.84	3.87	3.04
1.0	1.82	.16	2.52	.49	3.17	1.10	3.77	2.06	4.33	3.40
2.0	2.57	.22	3.56	.70	4.48	1.56	5.33	2.91	6.13	4.82
3.0	3.15	.27	4.35	.86	5.49	1.92	6.53	3.56	7.51	5.91
4.0	3.63	.32	5.05	.99	6.34	2.22	7.54	4.11	8.65	6.80

that in any given size of sewer velocities are nearly proportional to the square root of the gradient. Sewer sizes are decided upon after the maximum flow has been computed and the available gradient has been determined. For sanitary sewers, 6-inch is usually the minimum size; for storm water nothing smaller than 12-inch is ordinarily employed.

Permissible Velocities

Velocities should not be too low or too high. If the mean velocity in a sewer carrying domestic sewage be less than 2 feet per second, solids contained therein are likely to strand. Similarly in storm sewers, a velocity of at least 3 feet per second has been found to be necessary to transport the sand and pebbles which are washed from the surface of the roadways. Such velocities are called minimum self-cleansing velocities, and the gradients producing them are called minimum gradients. For a minimum velocity of 2 feet per second, the minimum gradients are:

1.24 ft. per hundred for 4-inch tile
.63 " " " " 6-inch "
.40 " " " " 8-inch "
.30 " " " " 10-inch "
.22 " " " " 12-inch "

On the other hand if velocities in sewers containing sand and pebbles be too high, an erosion of the invert of the sewer takes place

and this also is to be avoided if possible. Velocities in excess of 10 ft. per second are objectionable for this reason. It is apparent then that minimum and maximum permissible grades and velocities for all sizes of pipe should be observed.

When Ground Is Nearly Level

In flat districts it sometimes happens that sewers laid on minimum gradients drop more rapidly than does the surface of the ground. Sometimes also, the ground slopes upward while the sewer slopes downward. In either case, the farther the sewer is followed, the deeper it lies. It is often necessary therefore to pump sewage at the end of a long trunk sewer or lateral in order that it may be discharged into a stream or another sewer at a higher level.

Materials for Sewer Construction

Vitrified tile is very generally employed for sewers. These pipes have bell ends for jointing and usually have a thickness equal to $\frac{1}{12}$ of the diameter. The commercial sizes are 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 33, and 36 inches. Segmental blocks of vitrified clay intended to be laid by masons in cement mortar are often employed for the larger sizes. Concrete pipes made from Portland cement and sand or gravel, with and without reinforcement, have been used to quite an extent of recent years. Some trouble with these when laid in alkali soils has been encountered due to disintegration. For sewers of diameters greater than three feet, brick laid in cement mortar and reinforced concrete are very commonly employed. Sometimes a combination of these two is adopted, the lower half of the concrete ring being lined with hard burned brick the better to resist erosion. Wood stave and cast iron pipes are occasionally employed for sewer purposes but usually in special situations. The round sewer is by far the most common. Egg-shaped sewers are large at the top and small at the bottom and possess the advantage that when the flow is small in relation to the capacity, the velocity is likely to be self-cleansing. Horse-shoe-shaped sewers are often built where very large volumes of water have to be handled and where head room is restricted.

Maintenance of Sewers

Ventilation of sewers takes place to some extent through perforated manhole covers with which manholes are always provided. Unless solids are permitted to lodge in sewers and to remain there, no offensive odor is observable in the vicinity of manholes. In certain localities, the main traps on the house drains are omitted, in which case each soil pipe is a ventilator to the adjacent street sewer. To this as noted elsewhere, there are certain very important objections. Flushing of sewers is necessary at the upper or dead ends where sewage flow is a minimum, and at other places where the gradient is flat and where solids are likely to strand. It may be done by an automatic flush tank filled from city water pipes and discharged through a siphon; through permanent water pipes leading to manholes; by hose from nearby hydrants discharging into sewers at manholes, or by connecting the sewers requiring flushing with the roofs of houses and employing the rainfall for the purpose. Automatic flush tanks are not always dependable and are often wasteful of water. Their greatest field of usefulness is for sewers laid on gradients less than one per cent. Elsewhere, periodical flushing by hose through manholes gives the most satisfactory results.

Computation of Storm Water

It will be apparent that the quantity of storm water for which a sewer in a district must be provided will depend on the extent, the geometrical form and the topography of the area to be drained; on the portion thereof covered by buildings, impervious pavements, etc.; on the intensity and duration of the rainfall, and on the porosity of the soil. Many impirical formulas which take into consideration most of these elements have been proposed whereby the engineer may compute more or less approximately the quantity of storm water for which sewers in any district must be provided. These formulas, however, must be used with caution since they leave out of consideration certain elements which are known to be of importance and employ co-efficients, the determination of whose precise value is attended with difficulties. One of the most frequently employed formulas is that of McMath which has the form

$$Q=CR\sqrt[5]{SA^4}$$

in which

Q is the quantity of storm water in cubic ft. per second.
C is the portion of the rainfall reaching the sewer, the maximum value being about .90.
R is the maximum intensity of the rainfall in inches per hour (or cubic feet per acre per second).
S is the mean slope of the surface in units per 1000 and
A is the area in acres.

An illustration of the application of this formula to assumed data is given in the following problem: An area of 10 acres with a surface slope of 1 in 1000 is to be provided with a storm sewer. The maximum intensity of rainfall is 3 inches per hour. The character of the soil and the relative quantity of roofed and paved area warrants the assumption that .30 of the rainfall will reach the sewer. The quantity of storm water to be provided for is then given by the equation.

$$Q=.30x3x\sqrt[5]{1x10^4}=5.7 \text{ cubic feet per second.}$$

A reference to the Velocity and Discharge table above shows that a 12-in. pipe laid on a 3 per cent gradient will carry this volume of water. If owing to the situation, a 3 per cent gradient is steeper than can be secured, a larger sewer laid on a flatter slope would be selected.

Fig. 81 is a contour map of a village showing the sizes and gradients of a system of sewers for the conveyance of domestic sewage. Contour lines are lines drawn through places having the same surface elevation. A reference to the map shows that there are two ground slopes, one toward the Black river, the other and the steeper toward the White, and that the ridge lying between has an elevation about 22 feet higher than the water level in the Black River which in turn is 8 feet higher than the White. Because the White River is the lower of the two it has been chosen for the single sewage outlet in anticipation of a time when treatment of the sewage will be necessary. It will also be observed that when the drainage of the area toward the Black River arrives at the well from which it is pumped its level is 8.7 feet below the surface of the stream. The force main leading from this well terminates in a manhole at Proc-

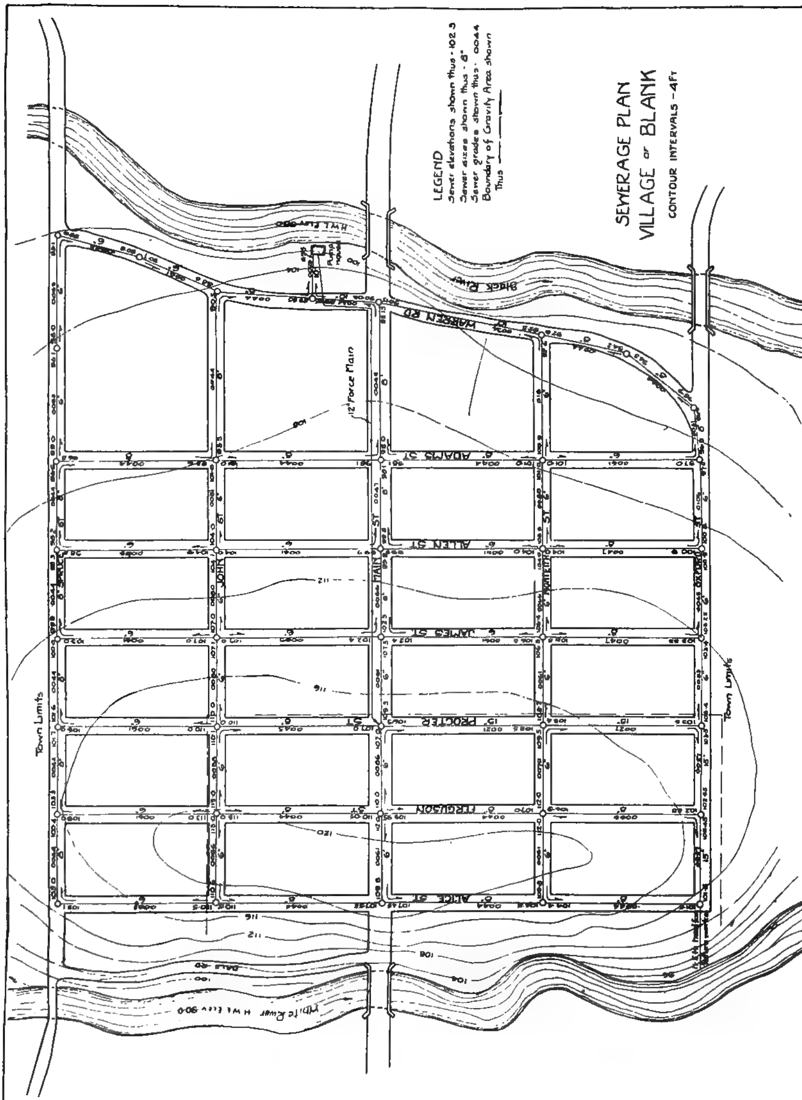

Fig. 81.—Typical sewer plan for village.

tor and Main Streets from which it gravitates to the outlet on the White River.

Costs

Recent costs for sewer construction in an Ontario municipality where the sizes were 9-in., 10-in. and 12-in. averaged $4.26 per foot, including pipes, laying, manholes, etc. This is equivalent to $22,-000 per mile.

Another Canadian city reports the approximate cost of vitrified sewers of the smaller sizes to be from $14,000 to $18,000 per mile.

A third Ontario municipality estimated $45,000 as the probable cost of laying 18,200 ft. of 8-in. sewers. This is equivalent to $2.46 per lineal foot or $13,000 per mile.

DISPOSAL OF SEWAGE

The Problem

The adoption of the water carriage system has created the modern problem of sewage disposal. As stated elsewhere, sewage is the water supply of a city or town after it has been used. It contains domestic and industrial waste, certain mineral matters and countless microorganisms called bacteria. It is commonly said that of 1000 parts of average American sewage, 999 parts are water and 1 part is solids half of which is in suspension and half in solution. Of this unit, it may further be said that half is organic and half inorganic. Because of its origin, sewage is approximately equal to the water consumption of the community from which it comes and for American cities is ordinarily taken as 100 gallons per capita per day.

If a beaker of fresh sewage be taken from a city sewer and observed it will appear as a turbid dirty water. If allowed to stand for some time a slimy sediment will settle out while the turbidity still remains. If allowed to stand sufficiently long putrefaction results. Gas is evolved. The liquid becomes clarified and a stable condition is reached. To bring about this condition on a large scale is the endeavor of the sanitarian. To convert the unstable sewage of a community into a stable and harmless liquid which will neither

endanger the life of the citizen nor offend by sight or odor is the problem that confronts him.

Methods of Treatment

The processes shown below, slightly modified from a classification proposed some years ago by Professor E. B. Phelps, are those which either singly or in combination are being or have been employed in the treatment of sewage.

1. Dilution.
2. Mechanical Processes.
   - (a) Screening.
   - (b) Sedimentation.
3. Biological Processes.
   - (a) Irrigation on land.
   - (b) Intermittent sand filtration.
   - (c) Treatment in septic tanks including the Imhoff or Emscher tank.
   - (d) Treatment in contact beds.
   - (e) Treatment on trickling or sprinkling filters.
   - (f) Aeration. (Activated sludge process.)
4. Chemical Processes.
   - (a) Precipitation.
   - (b) Sterilization.

Dilution

In a new and sparsely populated country dilution in streams, lakes, etc., is usually the sole method of treating sewage and in practically all cases where other methods have been adopted it constitutes the finishing process. Essentially it is one of oxidation in the course of which substances of the free ammonia and albuminoid ammonia classes are changed to nitrites and nitrates. The oxygen required for these changes is obtained mainly directly from the water in which it is in solution and indirectly from the air. When the processes of putrefaction are active the dissolved oxygen in the diluting water will be low and where the decay has resulted in stable forms, this ingredient will have reached something approaching its saturation value. Hence from a technical standpoint, the most simple and delicate measure of the pollution of a water way is the quantity of oxygen dissolved therein. Fresh water will carry dissolved oxygen equal to 4.04 grains per cubic foot at 68°F. but if the temperature drop to 32°F. the oxygen content may reach as high as 6.38 grains per cubic foot. These values represent for the temperatures given, a state of saturation and are frequently desig-

nated as 100 per cent. The discharge of sewage into a stream brings about a reduction in the quantity of oxygen dissolved in the water. The first indication of pollution is the disappearance of major fish life, for the existence of which 70 per cent of the saturation volume of oxygen is necessary. When the oxygen has become reduced below 30 per cent of saturation, the condition of the stream is one which becomes a nuisance during the summer season. It can be shown that if 23 volumes of fresh water whose oxygen content is at the saturation limit be mixed with one volume of representative American sewage, the oxygen content of the water will not be reduced below 75 per cent of saturation and putrefactive conditions will not occur. This ratio was practically the one adopted in the design of the Chicago Drainage Canal whereby large volumes of water from Lake Michigan were diverted to the Des Plaines and Illinois Rivers for the dilution of the sewage of the City of Chicago. Expressed in another way, the dilution was equal to 3.5 cubic feet of diluting water per second per 1000 population. This has not been sufficient to prevent disagreeable odors at all times. The International Joint Commission on Boundary waters some two years ago suggested among other things as a tentative standard for the Niagara and Detroit Rivers, a dilution of 4 cubic feet of water per second for each unit of the population. (This, however, had for its object, not the avoidance of a nuisance but the reduction of the load on water filters to what the Commission considered a reasonable value.)

Dilution either as a sole or as a final process is a real method of sewage disposal, and is one of the oldest and least expensive. In Europe it is very generally employed but in order to lessen the burden on the stream or other body of water receiving the sewage, some partial method by way of preparation is usually adopted. Hamburg and Dresden, Germany, are in this class. This is really what is being done in Toronto, Boston, New York, Belfast and London, England. The modern dictum is that no sewage be run into streams, lakes or the sea without preparatory treatment of some kind.

Screens

Sewage screens are of two classes, coarse and fine. The former are usually stationary, the latter mechanical. Coarse screens usu-

ally consist of parallel steel bars separated about 1½ inch in the clear. In fine screens of which there are many types, the openings may be as narrow as $\frac{1}{12}$ in. The function of the coarse screen is merely to remove large entities which in appliances for subsequent treatment might choke passages, stall pumps or otherwise prove troublesome. On the other hand, the fine screen may constitute a sole method of treatment prior to discharge into a stream or a large

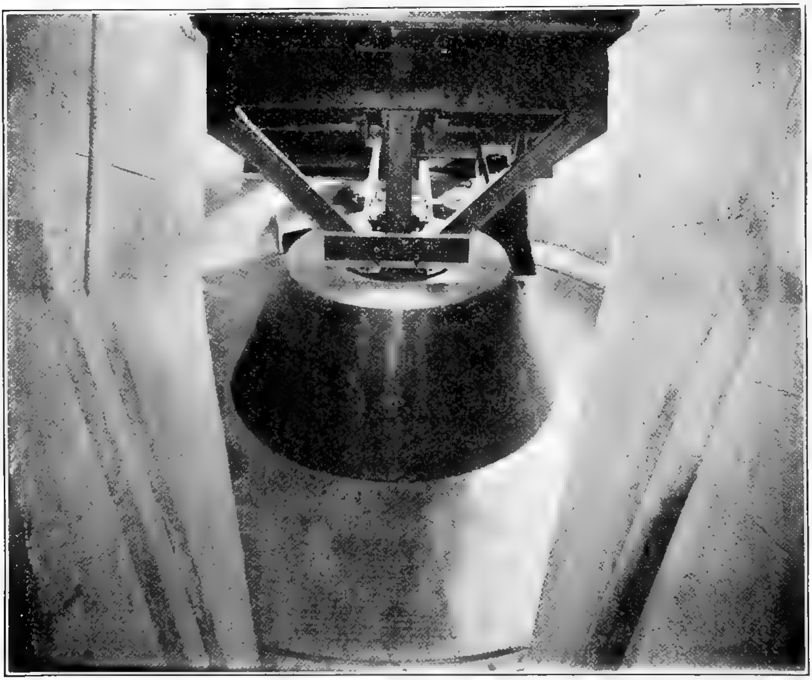

Fig. 82.—Riensch Wurl fine screen for sewage, Long Beach, Calif. The Sanitation Corporation, New York.

body of water. Hamburg and Dresden referred to above, treat their sewage on fine screens only, before discharging into the Elbe River.

Sedimentation

If the channel through which sewage is made to flow be widened and deepened, the velocity is reduced in the inverse ratio and solids in suspension heavier than water will settle to the bottom. If the

velocity be kept at about 1 ft. per second, grit and sand will subside but most of the organic matter will not. This fact is made use of in the design of grit chambers for the separation of sand from sewage containing street wash. The time of retention is usually from one minute to ninety seconds. To facilitate cleaning and to render the plant capable of handling wide variations in flow, grit chambers are built in two or three parallel units so arranged that one or more of these may be cut out of service if desired.

For the removal of organic matters, a much lower velocity and a much longer period of retention are required. Generally velocities below 3 in. per minute and a retention period greater than 2½ hours are not necessary or advisable. This will ordinarily remove 60 per cent of the suspended solids. A very desirable feature in all sedimentation tanks is that they be constructed so that sludge may be drawn off without interrupting the service.

Irrigation on Land

Broad irrigation or sewage farming is the intermittent application of sewage to land at such a rate only that the growth of crops is not interfered with. One acre to one hundred persons is about the accepted practice. It is adapted best to light soils. Unfortunately in wet seasons when the flow of sewage is greatest, the soil is least capable of absorbing it. In addition the manurial values are low, there are objectionable odors and there is always a sentiment against the use of vegetables grown on soils irrigated by sewage. For these reasons, irrigation is gradually giving place to other methods. Paris, France; Berlin, Germany; Pullman, Ill.; Los Angeles, Cal., are cities that at one time employed this method but have abandoned it, or are abandoning it in order to adopt more intensive processes.

Intermittent Sand Filtration

This consists in the intermittent application of sewage to prepared and underdrained beds of natural sand allowing one acre to 1000 persons. Between successive doses, aeration of the sand, which is essential to the success of the process, takes place. Intermittent sand filtration was put on a scientific and engineering basis chiefly through the work of the Massachusetts State Board of Health about

thirty years ago. In that State because of the presence of large areas of natural sand, many instances of the use of this method are found, some of which have been in continuous operation for thirty years. Usually and preferably, some preliminary treatment, such as sedimentation or screening is provided since this lessens somewhat the burden on the sand filter. The area is divided into beds usually of an acre each in size separated by earth embankments. Each dose consists of about ten inches in depth of liquor applied every third day or thereabouts. The surface of the filters requires occasional attention in the form of raking or harrowing and the removal of vegetable growths. No method of sewage purification produces a better effluent than intermittent sand filtration, 95 per cent removal of suspended matter and of bacteria being commonly obtained. Since large areas of natural sand at suitable locations and at moderate cost are essential, the number of cities that can avail themselves of the method is necessarily small.

The Septic Tank

A septic tank is a settling tank in which the period of retention varies from eight to twenty-four hours, and in which the accumulated solid matter is permitted to remain for long intervals at a time. To Donald Cameron of Exeter, England, is generally given the credit of placing it on a commercial basis for the treatment of sewage. As ordinarily constructed, it consists of a rectangular tank with bottom and sides and with or without a roof into one end of which the raw sewage is admitted. Sludge forms at the bottom and scum at the surface and in order to obtain an effluent of comparative clarity, the outlet lies between the two or is submerged. (Fig. 83.) The sludge in time becomes septic and undergoes a process of digestion in which a portion of the organic matter is converted into liquid and gas. The amount of solid organic matter actually liquefied or gasified may be as much as a third of the whole. Experience has shown that in a septic tank which has been long in service without being cleaned out and in which a great deal of sludge has accumulated no reduction in the amount of suspended matter contained in the incoming sewage takes place and the effluent is no better than the influent. Septic tanks should therefore be cleaned out from time to time to prevent this condition.

Closely related to the septic tank in the functions they are intended to perform are the hydrolytic tank of Dr. Travis, of Hampton, England, and the Imhoff or Emscher tank of continental Europe and America. In the upper chamber of each, sedimentation takes place, the solids passing through a slot to a lower chamber with which each is provided. In this lower chamber sludge digestion proceeds and any gases evolved in the processes are deflected by the sloping bottoms of the sedimentation chamber to the gas vents and do not mingle with the fresh sewage as it passes through. In the Travis tank but not in the Emscher tank, a portion of the fresh sewage is usually drawn from the upper chamber into the

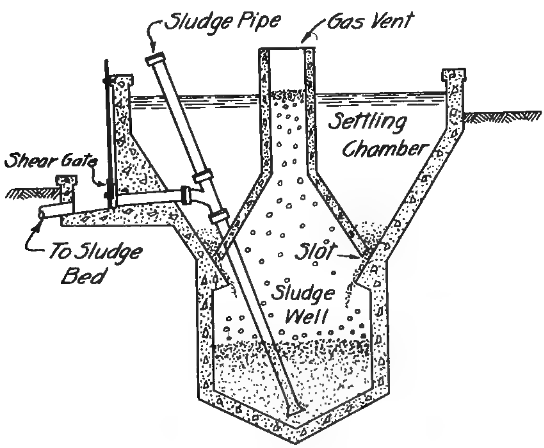

Fig. 83.—Section through Imhoff tank.

lower and passes thence to the outlet. In the Emscher tank the effluent is not rendered septic by coming in contact with the decomposing sludge.

Emscher tanks are generally designed so that the flowing-through period is from two to three hours. In cold climates, where sludge cannot be conveniently drawn and dried in winter, the common practice is to make the sludge chamber of capacity equal to six months' accumulation. The depth of tank from water level to the apex of the conical bottom of the sludge hopper is usually from 25 to 30 feet. Sludge is drawn by hydrostatic pressure through a sludge pipe provided for the purpose. This operation can be done without interfering with the flow of sewage. Nor-

mal Imhoff sludge is black in color, inoffensive to smell, parts with its water readily when run on properly underdrained sand beds, and in favorable weather, dries so that it can be handled on a spade in a few days. Its water content may be as low as 80 per cent. The gases which escape at the vents are mostly methane and carbon dioxide with smaller quantities of nitrogen and hydrogen present also.

The effluent from the Imhoff tank is merely clarified sewage from which perhaps 60 per cent of the suspended solids have been re-

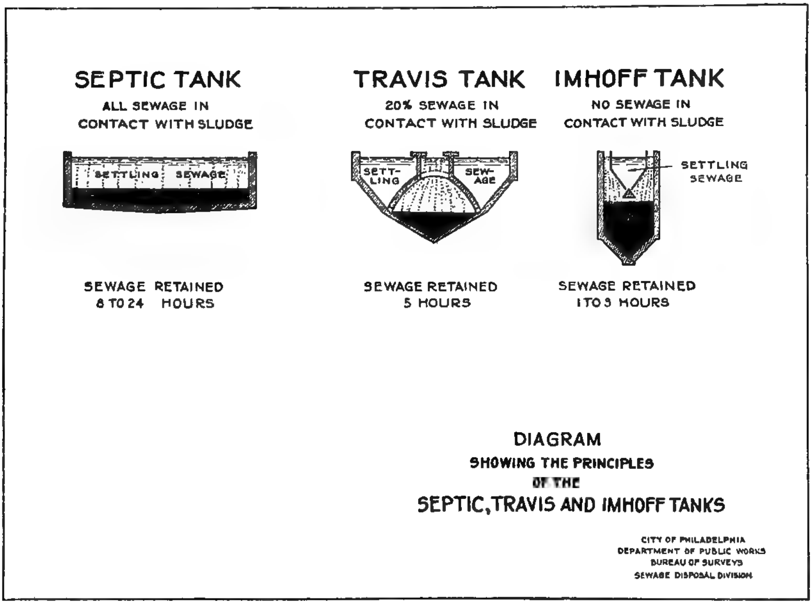

Fig. 84.—Septic, Travis and Imhoff sewage tanks compared, Bureau of Surveys, Philadelphia; Pa.

moved. It is putrescible and its bacterial content is very high. If an effluent better than this is required, it will be necessary to provide some subsequent treatment.

Generally speaking, Imhoff tanks in America have produced a sludge of excellent quality although in some installations the so-called "ripening period" has been very much longer than in others. The chief difficulty experienced has been a troublesome foaming or frothing which develops from time to time at the gas vents, espe-

cially in the summer season. This foaming causes the gas lifted sludge to overflow the walls and spread over the surface of the sewage in the sedimentation chamber. The phenomenon is often accompanied by offensive odors. Various remedies for foaming have been tried. Among them may be mentioned sparging the foam with water from a pressure hose, or diluting the liquor above the sludge in the sludge room with fresh sewage; drawing sludge

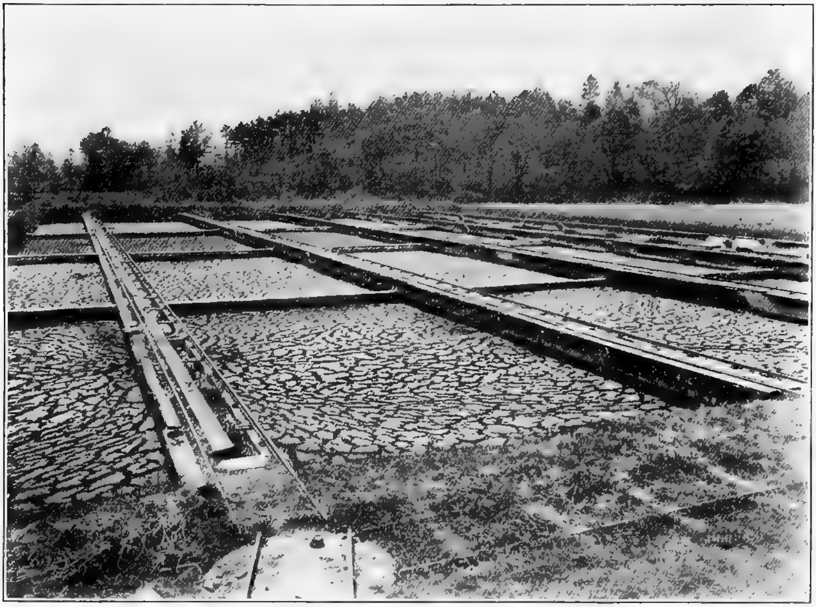

Fig. 85.—Dried Imhoff tank sludge, Atlanta, Ga.

and resting the tank from service for a time. Much of the trouble experienced with Imhoff tanks will yield to careful and intelligent operation.

Contact Beds

The contact bed is an outcome of the desire to secure more intensive filtration than was possible with the intermittent sand filter together with the belief that in many cases the excellent results obtained from the latter are not really necessary. To this end it was proposed to employ a much coarser medium. To prevent the sewage passing through the filter too rapidly it was proposed to

close the outlet thus holding the liquor in contact with the medium. Hence the name.

The contact filter consists of a water-tight chamber usually constructed of concrete and containing some filtering medium preferably hard and well adapted to resist decay and the crushing force of its own weight. Broken stone, brick bats, pebbles, etc., are some of the materials employed. The size may vary from ½ inch to 3 inches. The bed is usually 4 or 5 feet deep and is underdrained. It is allowed to fill from below until the liquor is just flush with the surface of the medium when the flow is diverted to another unit. Usually contact beds are built in multiples of 4 since in the complete cycle there are four operations viz., filling, standing full, emptying and aerating. The control is automatic in the smaller plants and the operation continuous since the four events are made to succeed each other always in rotation. At any time, one of the four beds is filling, another is standing full, a third is emptying and a fourth is aerating. If the nominal period for each is two hours, each filter will get three doses of sewage in twenty-four hours. The effluent is nonputrescible.

The contact bed possesses several advantages. It operates on a small difference of level or loss of head, this being practically little more than the depth of the filter. There is an absence of flies and odors; it is flexible in its operation, responding readily to wide fluctuations in flow; it lends itself to automatic control, is not interfered with by ordinary frosts and yields an effluent low in suspended matter. Against this there is the difficulty that it invariably becomes clogged by accumulated solids necessitating the washing and replacing of the medium every few years. The normal capacity of the contact bed is about one-third that of a trickling filter of the same area.

Trickling Filters

In the trickling filter the sewage liquor after preparation by sedimentation or otherwise is sprayed over a bed of coarse grained medium several feet deep through which it trickles in thin layers in the presence of the contained air. The bed is provided with an impervious bottom and underdrains and may or may not have sides. Every facility for washing out the underdrains and for the entrance of the atmosphere to the medium is provided. In this way the oxida-

tion of the organic matter is accomplished. Any material of a hard resistant nature such as broken stone, clinker or slag is suitable as a medium. Lath and brush have been tried and with gratifying results.

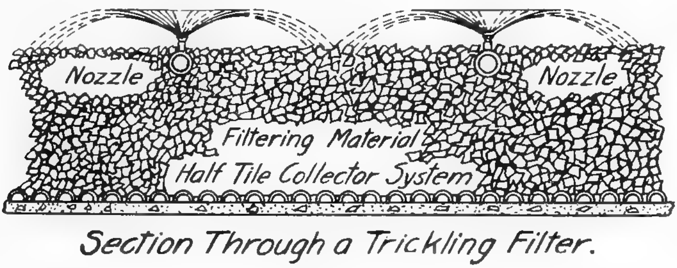

Fig. 86.—Section through percolating or trickling filter for sewage.

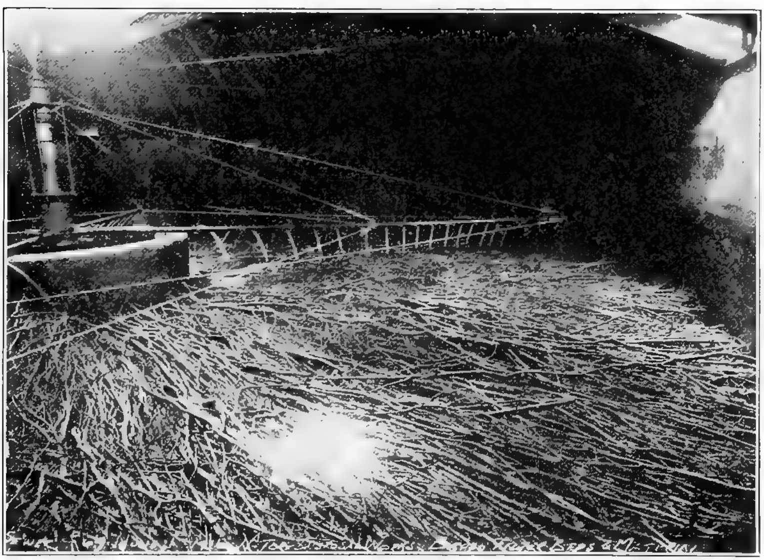

Fig. 87.—Interior of brush filter for sewage, North Toronto.

Various methods of distributing the liquor over the beds have been adopted. Fixed spray nozzles, revolving distributors of the Barker wheel type, traveling distributors of the Fiddian type, dash plates, perforated trays, etc., have all been employed. Wherever winter conditions are severe, moving distributors such as the revolv-

ing and traveling types must be housed to protect them from the frost. Nozzles are generally preferred in this country although the "head" necessary to operate them is very much greater than that required by traveling or revolving distributors.

One of the changes taking place in the liquor as it passes over the filter medium is the change of matter from a condition of semi-solution to a condition of true suspension. Because of this, there is in general more suspended matter in the effluent from a sprinkling filter than in the influent. To arrest this, special secondary settling tanks so-called, are usually provided. The sewage from a population of 20,000 people can be treated on one acre of percolating

Fig. 88.—Percolating filters. Peachtree Creek, Atlanta, Ga.

filter producing a nonputrescible effluent. If not overworked they will operate indefinitely. Objections to their use are the presence of odors and flies in the summer season and the somewhat higher head required by them as compared with contact beds. (Fig. 88.)

Activated Sludge

Activated sludge is produced in the first instance by the prolonged aeration of sewage until a condition of pronounced bacterial activity of the sludge contained therein has been established. The process bearing the name consists in passing sewage through tanks

containing a quantity of activated sludge previously prepared, the whole being meantime aerated and agitated by forcing air into the bottoms of the tanks. The object is to bring the sewage and the sludge into intimate contact and to consummate the coagulation of the colloidal constituents. This is followed by sedimentation of the sludge which is flocculent, granular, brown in color and slightly heavier than water. The supernatant liquor is normally clear and stable, the removal of suspended matter and of bacteria commonly reaching 96 to 98 per cent.

Usually there are five essential entities in an activated sludge plant,—an air compressor, an aeration tank, a settling tank, a re-aeration tank and some facility for dewatering sludge. After preliminary screening and the separation of grit, the incoming sewage is aerated by forcing air through porous plates or perforated pipes in the bottom of the aeration tank. This tank may be 10 to 15 feet deep and will have a period of retention of three to eight hours depending somewhat on the strength of the sewage to be treated. The liquor then overflows to a settling tank carrying part of the flocculent sludge with it. Sedimentation takes place here and the effluent is discharged without further treatment into the nearest stream. A portion of the settled sludge is pumped to the reaeration tank where it is further enlivened by aeration preparatory to being added to the stream of incoming raw sewage. The dewatering of the remainder of the sludge presents the real problem in the process especially if the plant be a large one. Treatment on sand beds, centrifuging, filter pressing, etc., are some of the methods that have been tried. As an offset to the difficulty and expense of dewatering, valuable fertilizing constituents are present in the sludge. The consumption of air will vary from one to one and one-half cubic feet per gallon of sewage treated.

An activated sludge plant is simple to construct, requires very little fall on which to operate, occupies a relatively small area and produces an effluent comparable in quality with that of the intermittent sand filter. Against this, it must be remembered that it requires capable and therefore fairly expensive supervision, that the cost of power for compressing air is a large item in the maintenance account, that the biological processes may be interrupted and destroyed by changes in temperature and in the composition of of the sewage, that the problem of inexpensively drying sludge has

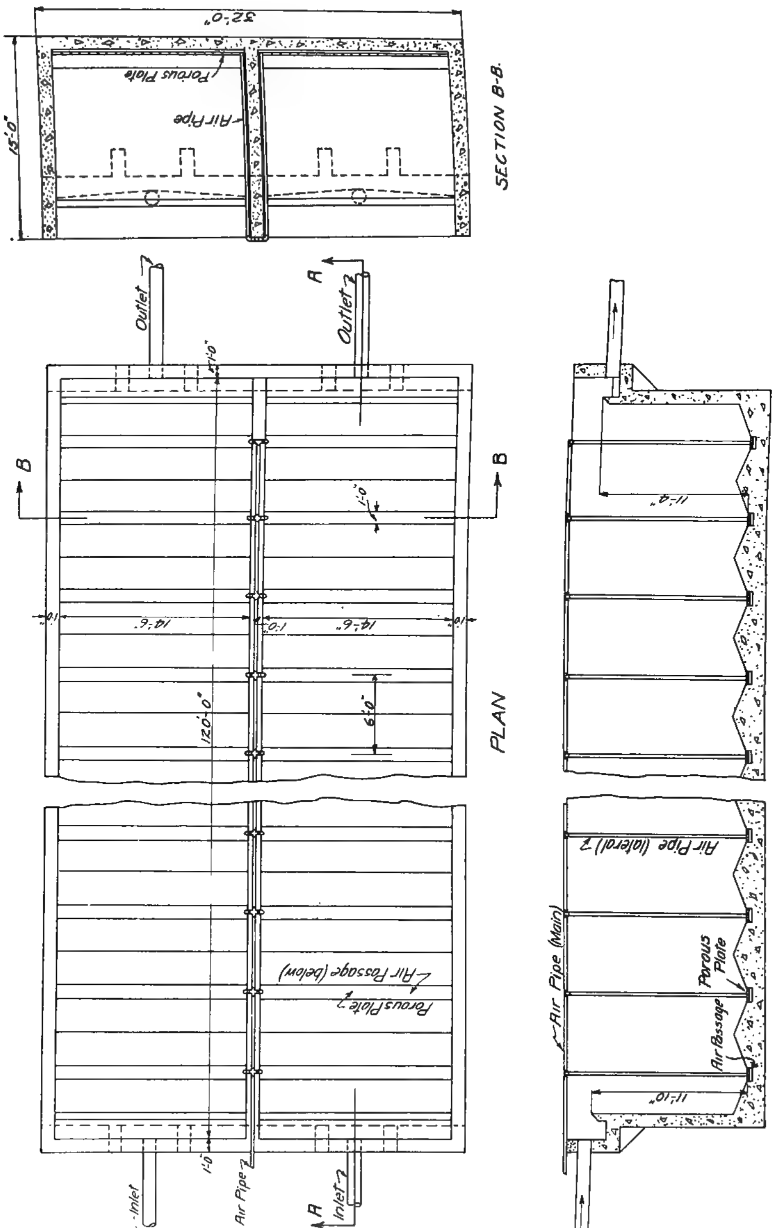

Fig. 89.—Aerating tank for sewage.

not been entirely solved and that the value of recoverable fertilizer has not been indisputably established.

Chemical Precipitation

Plain sedimentation produces only a partially clarified sewage effluent. The knowledge that there are valuable nitrogenous compounds in sewage which might be worked up into land fertilizers led to the belief that chemical precipitation would be efficient as to clarification and profitable also. The method was once largely

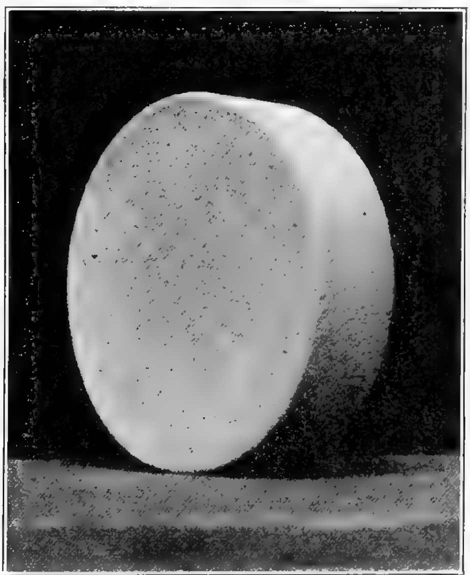

Fig. 90.—Filtros plate. Through these porous plates, air is forced in the process of aerating sewage.

employed in England but its promoters usually found that it was extremely difficult to secure the valuable nitrogen at a reasonable cost. It is said that in England alone a generation ago, as many as 450 patents covering processes of chemical precipitation had been granted. Chemical precipitation is in a sense a mechanical process. As to sewage treatment it is only preliminary and invariably gives a putrescible effluent. Certain reagents are added to the sewage whose interaction produces a large flocculent precipitate.

This is allowed to settle in a suitable tank and in so doing, entangles much of the suspended matter and takes it to the bottom. Despite the large number of processes proposed, the only one at all largely employed is the iron-lime one. Crude sulphate of iron (copperas) in solution and milk of slaked lime are added to the raw sewage. The results are shown in the following equations, the carbon dioxide being always in solution in the sewage.

$$FeSO_4 + Ca(OH)_2 = Fe(OH)_2 + CaSO_4$$
$$\text{and } Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$$

Hydroxide of iron, calcium carbonate and calcium sulphate are insoluble. In settling to the bottom, they carry with them the greater part of the suspended solids. This results in a very limpid effluent. The resulting sludge is disposed of by running upon land or sand beds, filter pressing or carrying to sea. The latter method is adopted at Providence, R. I., London, England, and Glasgow, Scotland. At Worcester, Mass., sludge is dewatered by filter presses. A peculiarity of the sewage of that city is that it contains a considerable quantity of sulphate of iron coming from the pickling vats in the wire manufacturing plants. Because of this, lime is the only reagent required.

Precipitation tanks are preferably continuous in their operation since it is very difficult in the intermittent type to fill and empty without seriously disturbing the contents of the tanks. The sludge should be removed sufficiently frequently to avoid the results of septic action. Generally its volume is 50 per cent greater than is obtained from plain sedimentation. Chemical precipitation would seem to have its greatest usefulness in the treatment of trade wastes of more or less unusual character. For the ordinary sewage, its day is rapidly passing.

Disinfection

Generally speaking, the development of intensive methods of treating sewage has resulted in deterioration of the quality of the effluent. For example, while the effluent from the intermittent sand filter is nonputrescible and clear, and the bacteria of the original sewage are largely eliminated, the effluent from a trickling filter though nonputrescible, contains much suspended matter and has

a high bacterial count. If from the second effluent, however, the suspended matter be removed, its discharge into a stream will not sensibly reduce the power of that stream to maintain its normal character. Phelps and Carpenter say in this connection: "We must conclude therefore that sewage purification by modern processes can be made to produce effluents which are reasonably clear and stable but which are still germladen and potentially infectious; that the discharge of such effluents into streams or tidal waters will not bring about physical nuisance or economic damage and that so far as the use of water for domestic and industrial purposes is concerned, such discharge is just and reasonable."

The following will give some idea as to the bacterial count of ordinary sewage after being subjected to different treatments:

Raw sewage, 5,000,000 per cubic centimeter.
Effluent from septic tank, 2,000,000 per cubic centimeter.
Effluent from trickling filter, 500,000 per cubic centimeter.
Effluent from sand filter 10,000 per cubic centimeter.

If a stream into which a sewage effluent is discharged be a source of water supply, it is very necessary that the water be made safe for human consumption by filtering or otherwise but it is also incumbent on the municipality responsible for the polluted condition of the stream to discharge a sewage effluent of reasonably good quality only and thereby reduce the load which the water filter has to bear. Disinfection of sewage effluent is a method of bringing this about. Heat, acids, ozone, hot lime, copperas, electricity and chlorine in some form or other are some of the means that have been employed but the last-mentioned is much more generally used than any of the others. Liquid chlorine has been used for this purpose a decade or more and has to a large extent superseded calcium hypochlorite commercially known as chloride of lime. The chlorine is added in quantities ranging from one to ten parts per million and in order to accomplish its work, a period of contact with the effluent varying from half an hour up is necessary. Facilities for this must be provided by the designer. Practical sterilization may be obtained by such means. One part per million is the equivalent of 10 pounds chlorine per million Imperial gallons of sewage.

The Choice of a Method

There is no standard method of treating sewage and no standard effluent that should be produced under all circumstances. A method that would be adapted to one situation might be insufficient or wasteful for another and an effluent that would be tolerated under one set of circumstances might be exceedingly dangerous under others. Because the size of the diluting stream, the uses to which it is put, the topography, the soil, the cost of power and labor vary widely, each situation is a problem in itself. The duty of the sanitarian is to select the method which will accomplish the necessary degree of purification in the most economical manner. With a dozen processes and their combinations to choose from, a fairly large range of selection is afforded.

To indicate how a few typical problems might be solved, a number of hypothetical conditions are assumed and for each a solution is suggested. Other solutions in most cases might also be proposed.

No. 1. Hospital accommodating 30 people. Site is approximately 8 feet higher than the prevailing level of the surrounding ground. Soil is a sandy loam. There is no stream in the vicinity.

For small plants, the automatic feature is most desirable. The 8 feet difference in level is sufficient to permit of draining the basement of the hospital and of utilizing the lower ground for a subsurface drainage area especially since the soil is suitable.

A two-chambered septic tank with an automatic siphon in the second chamber discharging into subsurface open jointed tiles laid 12 inches beneath the surface is suggested.

No. 2. City of 10,000 people. Treatment plant to be on bank of stream in which the flow is equal to 5 times the normal sewage flow. The proposed site comprises 50 acres of natural sand approximately 8 feet higher than the stream level. The available drop from the outfall sewer in the vicinity of the site to the level of the sand plain is about 6 feet.

The dilution ratio is 1 to 5, therefore, a very good effluent will be required. The presence of an ample area of natural sand suggests the intermittent sand filter. The fall to this area is adequate and the water level is sufficiently lower than the area to permit of underdrains for effluent being laid at a depth of 5 or 6 feet.

An Imhoff tank preceded by coarse bar screens and followed by

intermittent sand filters is suggested. The two-story tank will solve the sludge problem; the sand filter will give an effluent better than which is not produced by any commercially feasible process.

No. 3. City of 20,000 people on Western plains. Treatment plant to be on bank of stream which occasionally dries up during August. Soil is a heavy clay. Available fall is 15 feet.

Obviously a good stable effluent must be obtained. Intermittent sand filters are not possible because the soil is unsuitable. Sedimentation followed by treatment on percolating filters will give a stable effluent carrying, however, considerable suspended matter. Fifteen feet is about the minimum fall for such an installation and the available drop must be conserved.

Bar screens, two-story tanks, (the slots of which will be protected by the screens) percolating filters and a secondary sedimentation tank are suggested. A revolving or traveling distributor, housed against frost, will require less head to operate than nozzles and would therefore be recommended. The filters could be six feet deep.

No. 4. A city of 10,000 people in Eastern Canada situated on a small stream. Normal dilution 1 sewage to 5 water. An available fall of 9 feet. Power at the locality inexpensive.

The situation demands a very good effluent. This in combination with cheap power and an available fall insufficient for the installation of a percolating filter will suggest the activated sludge process.

Bar screens, aerating, settling and reaerating tanks and perhaps sand beds for drying sludge are suggested.

No. 5. City of 100,000 on estuary of a river discharging into the sea and in which the normal flow is 400 times the volume of the sewage. The stream is used for bathing during the summer season.

The dilution being 500 to 1, comparatively little treatment will be required especially as the stream cannot be used as a public water supply.

Fine screens for ordinary service and means for good dispersion of the sewage in the stream are suggested. Facilities for disinfecting the screened sewage during the summer season only should also be provided.

Costs

For average conditions, a sewage treatment plant consisting of bar screens, Imhoff tanks, percolating filters, secondary settling

tanks and sludge beds will cost $10 per capita of the contributing population. In an Ontario town recently, the population of which is 3,100, the cost of an activated sludge plant consisting of coarse screens, aeration tank, sedimentation chamber, sludge drying beds and mechanical equipment, was $31,000 or $10 per capita. Generally speaking, however, the capital cost for the activated sludge plant will be less than that of an Imhoff-percolating filter plant serving the same population but the cost of operation will be greater.

Developments in the art of sewage treatment during the past twenty-five years constitute an interesting evolution. During the first decade of the quarter century, the septic tank and the intermittent sand filter were primarily the subjects of investigation and study. During the next decade the interest shifted to the percolating filter and the Imhoff tank. At the present time it is the fine screen and the activated sludge process. And in each period substantial advancement has been achieved. While it is impossible to predict what the future has in store, it is reasonably safe to say that with the interest in these problems which municipal officials everywhere display, with the generous support which they give and with the investment of talents and labor on the part of specially trained and zealous investigators the world over, continued advancement in some direction is assured.

CITY REFUSE

Character of City Waste

City refuse includes those waste materials from urban communities not carried in the public sewers. It comprises ashes, garbage, rubbish, street sweepings and catch basin cleanings and dead animals. Garbage consists of waste incidental to the handling and cooking of food. Rubbish is generally understood to be rags, old clothes, paper, bottles, tin cans, shoes and such like materials. Street sweepings consist largely of manure but include earthy and other inorganic matters especially in unpaved districts. In any city or town the first three mentioned constitute the bulk of the municipal refuse, and will aggregate 1500 pounds per person per annum of which 1200 pounds are ashes, 200 pounds garbage and 100 pounds rubbish. The manner of collection will depend on whether the three

materials are to be treated separately or not. If the former, three separate receptacles are necessary. Sometimes ashes are collected in one receptacle and garbage and rubbish in a second. This method would be adopted when garbage and refuse are to be burned together.

Fig. 91.—An argument in favor of a standard receptacle for household waste.

Incineration

In the United Kingdom, a common practice is to collect ashes, garbage and rubbish in one receptacle and after a certain amount of picking, to burn all three together. The borough of Richmond, New York City, treats its refuse in this manner. Boilers for the generation of steam often constitute a part of the plant and the heat of combustion is utilized for this purpose. This steam in turn is employed to generate electric current for illumination and other purposes, to operate hydraulic presses for compacting tin cans, to operate mortar grinders and magnetic separators for salvaging iron in boiler ashes or for pumping. It is often difficult, however, to find a use for all the power thus generated. In some cases on the other

hand the incinerator supplements at peak load the output of a coal-fired steam power plant. On this continent, ashes are generally employed for filling low ground and rubbish and garbage either burned together or the rubbish burned and the garbage subjected to "reduction" whereby grease and fertilizer are recovered. In the process of incineration, an important essential is to have the temperature of the products of combustion sufficiently high to prevent offensive odors in chimney gases. This temperature is 1200 F. or thereabouts. The preliminary draining and drying of the materials to be burned, the forced draft, the mutual assistance type of

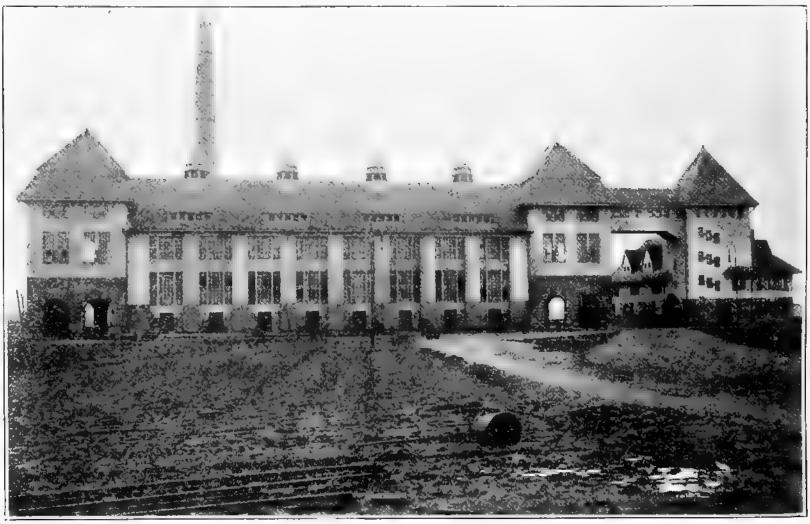

Fig. 92.—An incinerator for municipal refuse at Frankfort-on-the-Main, Germany. The heat is used for the generation of electric energy.

grate, the combustion chamber and the auxiliary fuel fire are some of the means whereby this is more or less satisfactorily accomplished.

The city of Buffalo, N. Y., for upwards of fifteen years has practically paid for the disposal of its rubbish by sorting and selling the valuable portions and by employing the rest as fuel for the generation of steam. After being dumped into receiving hoppers, the rubbish is conveyed on slowly moving endless belts along the length of a large sorting room. Attendants stationed on either side of this belt pick out all merchantable articles such as newspapers,

rags, bottles, etc. These articles are baled and sold. The steam generated is used to operate a sewage pumping station in the same locality.

For 1918 the operating account stood as below:

Receipts:		
From sales of salvaged material		$47,865
From sales of steam for power		8,560
Total receipts		56,425
Expenditures:		
Labor		$48,689
Maintenance and Repairs		5,711
Interest		1,440
Total Expenditures		55,840
Excess of Receipts over Expenditures,	$585.	

The figures, of course, do not include the cost of collection. It should be remembered also that it is very difficult to eliminate the unsanitary features from the sorting operations.

Reduction

Of reduction methods there are two broad classes, the *drying* and the *cooking.* In the former the garbage is ground and passed through direct heat dryers which operation brings about the evaporation of moisture and the break-down of cell structure. The dried product is then treated in extractors using gasoline as a solvent for the grease. In the cooking process the garbage is steam-treated in digestor tanks. The product is then relieved of its water and grease content by pressing. In either case, the solid residue after the grease has been extracted is called *tankage* and is manufactured into a fertilizer. Obviously, the odors are more difficult to control in the drying process than in the other. The grease content of city garbage will sometimes run as high as 3 per cent. It is used in the industries for the manufacture of glycerine, stearic acid, candle tar, soap fats, etc.

In 1918 Columbus, Ohio, treated in its reduction plant 28,565 tons of garbage at a total cost including taxes, interest, and depreciation of $71,911. The total revenue was $79,344. This meant a net profit to the city of $7,433. In the year 1919 Washington, D. C., reduced 53,258 tons of garbage at a total cost of $273,330. The

receipts from the sale of by-products were $287,261 leaving a net profit to the city of $13,931. In neither case is the cost of collection included.

WATER SUPPLY FOR THE ISOLATED RESIDENCE

Wells

Wells will always be the chief source of water supply for farm houses and other isolated residences. To prevent contamination

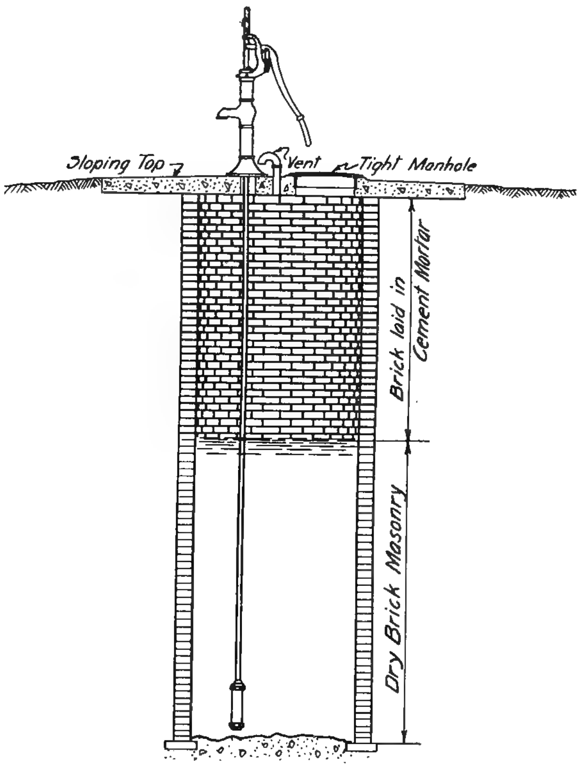

Fig. 93.—Dug well, adequately protected.

from surface sources the well curbing should be made impervious to seepage for a depth of ten feet or thereabouts below the surface. The well roof should have a diameter 4 feet greater than that of the well

and should slope outward. Drippings from the pump and filth from animals of all kinds should be excluded. Ventilation is not always necessary but if the water contain gases in solution means for their escape should be provided. A 3-in. "return bend" as shown in Fig. 93 is all that is necessary.

Rainfall

Roof water is preferred to well water for laundry and bath purposes and the soft-water cistern has come to be a common article of equipment for the farm house, and in some urban communities

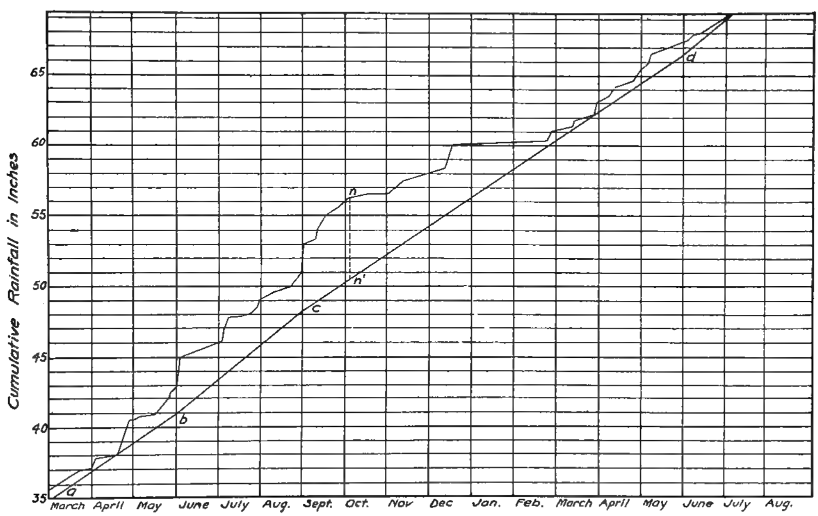

Fig. 94.—Mass curve for rainfall, Toronto.

where the ordinary municipal supply is very hard. An estimate of the annual yield from a roof of known area can be made if the rainfall be known. For example if the rainfall be 25 inches per year and the roof in question be 40×40 feet in plan, the volume of water will be $40 \times 40 \times 2.08 \times 6.25$ or 20,800 Imperial gallons annually, sufficient to provide a family of four with about 14 gallons of water each per day. If, however, we assume, as is sometimes done, that the consumption during the three summer months is 25 per cent greater per day than during the rest of the year, the per capita allowance will be 13.5 gallons per day for nine months and 17 gallons per day for the remaining three months. Obviously a

cistern of 20,800 gallons capacity will not be required since the rainfall is distributed over twelve months of the year. Indeed if the rainfall were uniformly distributed over the 365 days of the year, very little storage would be necessary.

Fig. 94 shows a portion of a so-called "mass curve" for rainfall in the vicinity of Toronto, on which cumulative precipitation in inches is plotted vertically and time horizontally. A water consumption line *a b c d* is drawn tangent to the mass curve but below it. The greater steepness of this latter curve for June, July and August is indicative of the greater consumption of water which prevails during those months. When rainfall exceeds consumption, the mass curve will be the steeper; when consumption exceeds rainfall, the consumption curve will be the steeper. The vertical intercept between two curves denotes the amount of storage that will have to be provided at the time in question. Points of contact between the two curves indicate that the water in storage has all been consumed.

The maximum intercept *n′ n* it will be observed, is 5.9 inches and occurs early in October. This means that the citizen whose roof area is just sufficient to provide him with the water necessary for his household and who uses water according to the rule set forth above, would have to provide storage equivalent to 5.9 inches of water on the horizontal projection of his roof area in order that he would neither waste his supply in times of abundance nor want in times of drought. For the illustration cited, the storage would be 5900 Imperial gallons. This could be contained in a cylindrical tank 12 feet in diameter and 8½ feet deep.

The Gravity System

The least expensive method of supplying the ordinary rural home with running water is the gravity system. Here water is forced by pump into an elevated tank (probably in the attic) from which the various fixtures are supplied. Either wooden or metal tanks are suitable. If the former, they should be metal lined and in all cases protected against frost. An expansion pipe leading from the top of the kitchen boiler and terminating in a gooseneck over the tank provides for the escape of steam from a boiling tank and also permits air to enter when the water has to be drawn out of the system. There is little objection to having the supply *in* and the supply *out* one and the same pipe. An overflow should be provided.

The Pneumatic System

In the pneumatic system, water is forced by pump into a closed cylindrical steel tank containing air. The incoming water compresses the air, (incidentally dissolving a portion of it) and this compression can be made sufficient to force the water out through a pipe leading from the bottom of the pneumatic tank to the various house fixtures. The pump may be operated by hand, windmill, gasoline engine or electric motor. If the latter be employed, a controller which automatically starts the pump and stops it at predetermined minimum and maximum pressures should be provided. The pneumatic tank may be placed in the basement or underground if desired in which case a cool supply is assured.

Because of the absorption by the water of a portion of the air contained in the tank, some means of supplying air from time to time is necessary. Most pumps for pneumatic systems have such devices.

Costs

A pneumatic water system for a dwelling house including motor-driven pump, automatic pressure controller, 100 gal. pneumatic tank and accessories will cost about $200.

COMMUNITY WATER SUPPLY

Sources of Water Supply

Rain is the primary source of all water supplies. The precipitation is divided into three portions, viz., that which evaporates, that which runs over the surface to join the streams and other bodies of water and that which is absorbed into the soil. The latter, varying from 10 to 80 per cent of the rainfall depending on the character of the surface, percolates downward until it comes to some impervious layer such as rock, clay or a water-filled soil. Then it begins to flow laterally and finally arrives at the surface as visible springs or as those invisible springs that feed the streams and constitute the bulk of their dry-weather flow. It sometimes happens, as in the case of the Dakota sandstones, that the springs are hundreds of miles distant from the place of original precipitation.

The top of the water in a water-filled soil is called the *ground*

water surface or *water table.* It is almost never level, is lower at times of drought than after rainfalls, conforms in a measure to the profile of the ground and at the edge of streams coincides with the level of the surface of the water therein. A well is said to "strike" water when it is sunk to a depth reaching this ground water surface. A well or stream is said to "dry up" when this surface, in the course of its never-ending fluctuations, drops below the bottom of the well or the bed of the stream. Because of the natural filtration process through which ground waters pass, they contain as a rule little organic impurity although their mineral content may be large. Surface waters in the form of streams and lakes and ground waters obtained from wells are the common sources of domestic and community supply. In America, the consumption of water is commonly taken as 100 gallons per person per day.

Wells

Wells may be excavated, driven, or drilled. In the second type the casing, provided with a point and strainer, is driven into the soil until the ground water is reached; or its lower end is left open and the soil within lifted by water-jet or other means as the tube is forced down. Drilled wells are sunk to depths greater than those for which the driving process is feasible, three thousand feet being not uncommon. Casings are necessary except in solid rock where they may be omitted. As water cannot be lifted to a pump by atmospheric pressure a height greater than about 25 feet, deep-well pumps become necessary where the ground water is far below the surface. These pumps are lowered into the bore of the well and are operated by reciprocating action from an engine at the surface. As pumping inevitably lowers the ground water surface in the vicinity of the well, it sometimes happens that wells in close proximity interfere with each other's yield. The air lift is a simple but not efficient method of lifting water by means of compressed air. There are no moving parts to the air-lift pump.

Lake and River Intakes

Intakes from rivers and lakes should be designed so that they operate at all stages of water level, that they are not in danger of being covered through the action of currents or waves, that the quality of water is as good as can reasonably be obtained and that

fish and débris are excluded. Frequently an intake consists of some form of timber or concrete crib sunk in the water from which a pipe is laid to a pump-well adjacent to or below the pumphouse on shore. At the shore end, screens are provided. The suction pipes of the pumps dip into this well. If the intake pipe be of proper size, little difference in level between the lake or stream and the well will be observed when the pumps are in operation. Tower intakes built upon lake bottom, standing well above permanent water level and provided with inlet ports controlled by sluices have been constructed by a number of the larger cities on the Great Lakes.

Power Pumping

The relative efficiencies of various types of steam pump may be roughly indicated from the following tabulation of the average

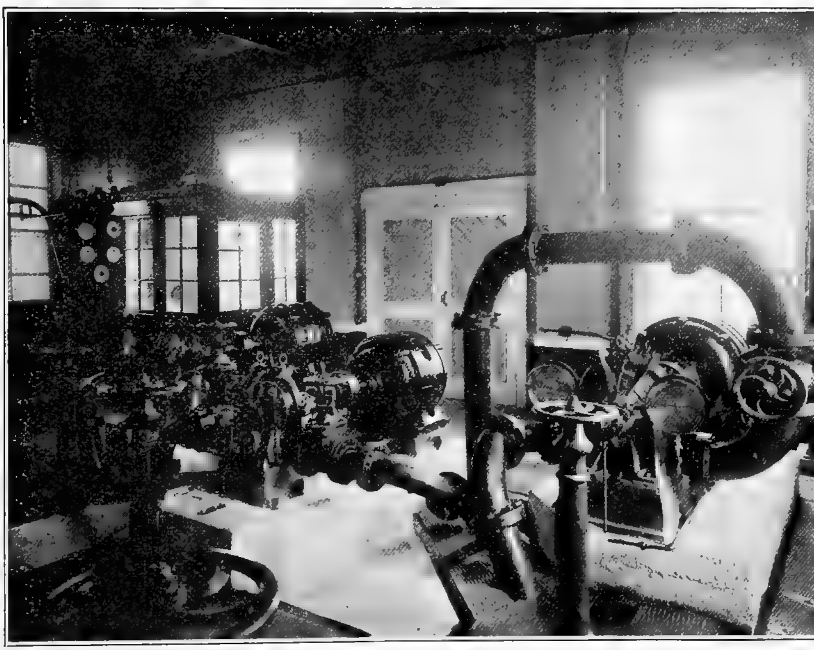

Fig. 95.—Interior of Rosedale Pumphouse, Moose Jaw, Saskatchewan.

"duty" of each class, duty being the number of foot-pounds of work accomplished per 1000 pounds of steam consumed:

Duty per Thousand Pounds of Steam

Single cylinder boiler feet pumps,	4,000,000 ft.-pds.
Duplex pumps	15,000,000 " "
Duplex compound non-condensing	30,000,000 " "
Duplex compound condensing	40,000,000 " "
Compound condensing fly wheel	120,000,000 " "
Triple expansion condensing fly wheel	150,000,000 " "

It is apparent, therefore, that the noncondensing reciprocating single expansion steam pump is a very inefficient machine but it is also true that in plants of moderate size, the extra cost of the most economical type of steam pump would not be commensurate with the saving in fuel costs resulting from its use. In any locality where electric power is not expensive the use of electric energy for waterworks service should receive careful study. Its advantages are its economy and the fact that it lends itself well to automatic control. Some kind of reserve, steam or gasoline, will usually be necessary to insure a service at times when the electric supply fails. In any case, in order that such contingencies as repairs and alterations may be anticipated, some form of duplication in the pumping plant should be provided.

Reservoirs

Where a variable supply accompanies a constant demand or a constant supply a variable demand, or where the variation in the supply is different from that of the demand, reservoirs are necessary. Cases in point are the following: An impounding reservoir may be necessary to retain the flow of a stream having a variable seasonal discharge for the use of a city whose more or less constant daily demands are less than the flow of the stream at certain periods and more at others. Cisterns for roof water are necessary because the rainfall varies in a way quite different from the needs of the household dependent upon it. Deep well pumps and filters may supply water at something like a constant rate during twenty-four hours of the day and a reservoir is necessary to receive the surplus when supply exceeds the consumption and to make up the shortage when consumption exceeds the supply. Reservoirs afford a considerable measure of protection against an interruption in a water supply due to accidents to pipe lines or machinery. It is sometimes more economical where reservoir costs are very high to secure

the flexibility which a reservoir affords by other means, e.g., by increasing the number of sources or by installing reserve plant.

Reservoirs are built of earth, concrete, steel and wood. Earthen reservoirs must be lined to prevent escape of water. These linings are usually of selected clay (puddle) protected by concrete or crushed stone or gravel. Concrete laid in segments with separating joints filled with tar or asphaltum is an alternative method. Monolithic concrete reinforced with some light steel fabric has been successfully employed in cases. The reinforcement if sufficient in amount, affords an adequate protection against shrinkage and settlement cracks.

Concrete is an ideal material for the below-surface reservoir. Minor leakages which are unsightly in an elevated concrete tank, are of no concern in a reservoir below the ground surface. It has not always been possible to construct above-ground concrete tanks that are absolutely impervious to water.

The once common cylindrical steel standpipe has given place pretty much to the elevated tank on a steel tower. This change has come about through considerations of safety, economy, and esthetics.

Wooden tanks are often built where low first cost is essential or where structures are likely to be temporary only. In railway service and in the industries their most important field exists.

The function of the storage reservoir and its relation to some other elements of a water supply system are exemplified in the following illustration:

A city of 20,000 people located on a plain is to draw its normal supply (2,000,000 U. S. gal. per day) from a lake 20 miles distant, the elevation of which is 240 feet above the city. A normal city pressure of 80 pounds per square inch will be assumed as the lowest permissible. Two solutions suggest themselves, viz., (1) direct connection by pipe line from the lake to the city mains in which case no pumping will be necessary and (2) a reservoir in the city to be fed by gravity flow from the lake supplemented by subsequent pumping into mains with or without an elevated tank to give flexibility.

If the former be adopted, the pipe line will have to have a capacity equal to the maximum fire demand (probably not less than 5,000,000 gal. per day for short intervals) during which time the city pressure must not fall below 80 pounds per square inch. For this

a 30-inch diameter pipe is necessary and it must be constructed to resist high pressures. If the second scheme be adopted, a pipe line from the lake capable of delivering 2,000,000 gal. per day into an open reservoir in the city and therefore against no back pressure, is required. For this a 16-inch pipe will be adequate. It will therefore be conceivable that the second scheme, notwithstanding its greater complexity, may be the more economical.

Distribution Accessories

Gate valves are placed at intervals in a distributing system so that sections thereof may be cut out of service for test, repair or extension. Where intersecting pipes are cross-connected, a common practice is to place one valve on each of the four radiating pipes, especially if the mains be important ones. Lines of fire hose and the suction pipes of fire engines are connected to the distribution system at *hydrants*. Hydrants are one-way, two-way, three-way, etc., depending on the number of hose connections provided. In order that drop in hose pressure may not be excessive, hydrants should be spaced so that no hose line need be longer than 500 feet. *Check valves* in mains permit water to pass in one direction only. They are actuated by water pressure entirely. *Air outlets* are placed at the summits of pipe lines having rising and falling gradients alternating. These permit the escape of accumulated air which always collects at the highest points of the line and if not removed may interfere with the flow of water. When automatic, they permit the escape of air but not of water. *Air inlets* are provided in pipe lines where the emptying of the pipe would otherwise create a vacuum under which it might collapse. When the pipe again fills, the inlet automatically closes. *Flexible joints* are often used on subaqueous pipe lines to enable the pipe to conform to the contour of the bottom upon which it lies. They are usually of the ball-and-socket type, the ball being a segment of a true sphere. A change of direction of a few degrees is possible at each such joint. *Underwriters fire pumps* are fire pumps of superior construction which conform to the specifications of the National Board of Fire Underwriters as to material, workmanship and capacity. *Blow-offs* are outlets placed at the low points in a pipe line through which, when necessary, the pipe may be emptied. A *by-pass* is a connection

between the two sections of a pipe separated by a gate valve. The by-pass itself contains a small gate valve. By opening the by-pass, pressures on the two sides of the main gate valve may be equalized prior to opening, thus facilitating that operation. By-passes are required on large pipes only. *Relief valves* set to discharge at some predetermined pressure, are sometimes provided for the protection of mains and plant against excessive pressure. In *direct pumping* service, the pumps deliver water as required direct to the distribution mains, no equalizing reservoir being employed. *Water hammer* is the combination of phenomena, among which are shock and greatly increased pressure, which occurs where the velocity of water moving in a pipe, is suddenly reduced or stopped altogether.

Distribution System

The size and arrangement of pipes in a distributing system are determined to a greater extent by the fire demands than by the domestic and industrial needs. This influence, moreover, is much more significant in small towns than in large. For instance a town of 5000 population, consuming 100 U. S. gallons of water per capita per day, has an average demand of .77 cubic feet of water per second and a probable fire demand of 2.8 cubic feet per second. A city of 50,000 population has an average demand of 7.7 cubic feet per second and a probable fire demand of 8.8 cubic feet per second. The usual plan is to lay out the mains on the gridiron system and to have cross-connections at each intersection. If four valves be provided at each cross-connection, one in each line, only one side of a block need be cut out of service when alterations or repairs are necessary. This, however, is done only at intersections of larger mains. At other intersections, the question of cost operates to reduce the number of valves to two at an intersection or sometimes less than this. An advantage of having pipes cross-connected is that when water is drawn from the mains at any point, the flow reaches that point from all parts of the system. Large feeders preferably running in both directions, must be provided every half mile or so and from these the cross-mains and smaller pipes draw their supply. Blind ends are avoided as far as possible. Usually the smallest size of main is four inches. In many municipalities, however, the minimum size is 6 inches for mains having fire hydrants. Here again

the fire demand controls. The loss of head due to friction in 400 feet of 4-inch pipe supplying two lines of fire hose from one end only, is over 60 feet equivalent to a drop in pressure of 28 pounds per square inch.

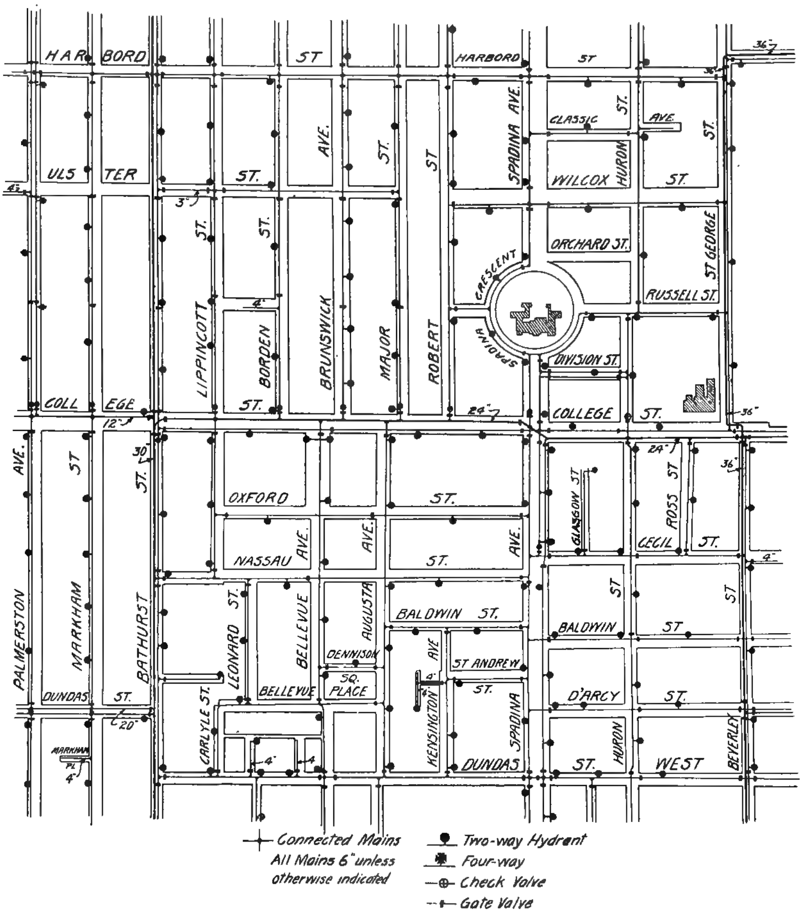

Fig. 96.—Portion of water distribution system, City of Toronto.

Fire Service

High pressure fire service mains are sometimes provided in the business and industrial sections of large cities. In these lines, in

times of fire, the fire pumps maintain a pressure of perhaps 300 pounds per square inch. If fire service pipes be connected at all with the general distribution system, the latter is usually protected by check valves which exclude fire service pressure and water from the general distribution mains.

Separate Services at Different Elevations

Where the differences in ground elevation in a city vary widely, it is expedient to have two or more separate services each serving a district of its own. The advantage of this is that it obviates the excessive pressure in the low-lying section resulting from supplying an adequate-pressure in the high level section where only one service is provided. In addition it further eliminates the cost of pumping much of the water against a needlessly heavy pressure. In the city of Toronto there are three main pressure zones—the low, the medium, and the high—besides two other minor pressure areas. The pressure in the low district is largely determined by the level in an open reservoir with which its main feeders are directly connected. The medium and high level districts are served by direct pumping from an uptown pumping station. No reservoirs enter the problem in the case of these two districts.

Figure 96 shows the distributing system for a portion of Toronto, a city of 550,000 people. The district below College Street is the low pressure zone; that above, the medium. Large or medium-sized feeders will be observed on Bathurst, Bloor, Beverley and College Streets. It will be seen that the low pressure district mains are connected with the medium pressure district mains but that check valves are interposed in all cases. If they open at all, they open toward the higher pressure. Ordinarily they are closed. If, however, a section of the medium pressure district be cut off from the rest of its district by closing the necessary gate valves, the check valve between it and the low pressure district will open and that section will be supplied with water from the low pressure district. It will be observed, also, that not all intersecting pipes are cross-connected and that the number of gate valves per intersection is probably less than two.

Costs

For elevated steel water tanks on towers of the height usually required for municipal waterworks systems, the cost will be about $175 per thousand Imperial gallons capacity. This will apply to structures holding up to 75,000 gallons. For similar tanks of greater capacity this figure might be reduced to about $150.

An Ontario city recently closed a contract for the construction of a reinforced concrete covered reservoir of capacity 2,000,000 gal. for $65,800. This is equivalent to $32.90 per thousand gallons capacity.

The City of Cleveland recently received tenders for the construction of a reinforced concrete reservoir of capacity 125 million gallons. The lowest tender $2,205,248, which included piping, valves, etc., is equivalent to $17.60 per thousand gallons capacity.

The following are recent costs of waterworks construction in Ontario. The figures include cost of pipes, specials, valves, hydrants, laying and inspection:

6-in.	cast	iron	pipe	$ 2.70	per	lineal	foot.
8-in.	"	"	"	3.70	"	"	"
12-in.	"	"	"	5.75	"	"	"
18-in.	"	"	"	12.00	"	"	"

A 16-inch pressure pipe 6,200 feet long was recently constructed in an Ohio town for $7.25 per lineal foot.

PURIFICATION OF WATER

Processes

Waters which are most suitable for domestic purposes are odorless, tasteless, colorless, reasonably soft, free from organic impurities, suspended matter and objectionable bacteria. Many natural waters, particularly those having a surface origin, do not meet this specification and some artificial treatment then becomes necessary. This treatment may consist of one or more of *aeration, sedimentation* plain and with coagulants, *filtration, softening* and *sterilization,* the selection depending on the character of the water to be treated.

To increase the dissolved oxygen content and to remove gases that produce objectionable tastes or odors, aeration is employed.

Spraying nozzles, waterfalls and fountains are some of the means adopted for this purpose.

Effective sedimentation where finely divided matter is involved, can be accomplished only where the velocity of the water is low. This necessitates widening and deepening the channel and providing sufficient length that slowly settling particles will have time to reach the bottom. A chamber of this description is called a sedimentation basin. A retention period of four or five hours will accomplish much with very turbid waters but perfect sedimentation can be realized only after very long periods and in water practically quiescent. Something approaching this condition obtains in many of our larger lakes at points remote from sources of pollution. It is very easy to lengthen the period of retention so that the additional improvement will not be commensurate with the increased outlay. This is especially true where, as is often the case, sedimentation is preliminary to other treatment. Bacteria are greatly reduced in numbers by plain sedimentation.

The addition of certain coagulating reagents renders the process of sedimentation more efficient, and in any event is necessary where color and turbidity are high. The reagent, usually alum, forms with the lime present in the raw water, a flocculent precipitate which as it subsides draws the suspended matters down with it. The quantity of alum added will vary from 1 to 5 grains per gallon the equivalent of 143 to 715 lb. per million gallons. Where sedimentation is preliminary to filtration it is considered unnecessary to reduce the turbidity below 40 parts per million since the filters will remove this without difficulty. The period of sedimentation in such a case will be from one to five hours. Facilities for removing the settled sludge must be provided.

Filtration

Generally speaking this refers to the passage of water through a layer of sand. The operation is a mechanical one in that the layer of sand acts as a strainer but it is known to be chemical and biological also. The difference in level between the water surface above the sand and that in a chamber connected with the under-drains is called the loss of head. This is occasioned by the frictional resistance offered by sand to the passage of water. The rate of filtration according to Hazen is given by the equation:

$$v = cd^2 \frac{h}{l} \frac{(t+10)}{60}$$

Where v is vertical velocity of water column in meters per day, c is a coefficient depending on the character of the sand, its cleanness, etc., and varies from 400 for old dirty sand to 1000 for new clean sand, d is effective size of sand grains, h is loss of head, t is temperature in degrees F. and l is thickness of sand layer. Other things being constant, it is clear that the rate of filtration varies directly as the loss of head and inversely as the depth of sand layer. In Fig. 97, h is the loss of head. Obviously when the outlet is completely closed h vanishes and no water filters through. The following

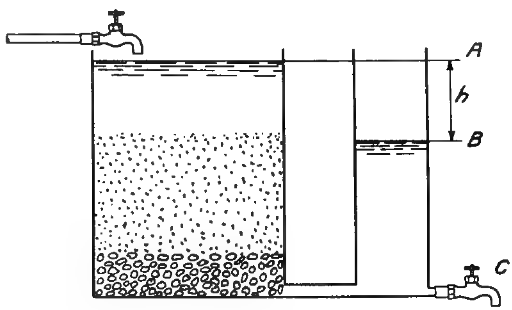

Fig. 97.—Diagram showing "Loss of Head" in sand filter.

table, taken from the "Waterworks Handbook" has been compiled with the aid of the Hazen equation above. It should be remembered that

1 meter of depth = 1.07 million U. S. gals. per acre = .895 million Imperial gals. per acre.

LOSS OF HEAD IN FEET FOR VARIOUS RATES OF FILTRATION
$c = 700$ $l = 3$ ft. $t = 50°$

TABLE LX

RATE OF FILTRATION IN MILLION U. S. GALS. PER AC. PER DAY	EFFECTIVE GRAIN SIZE—MILLIMETERS			
	.20	.30	.40	.50
1	.10	.04	.02	.02
5	.50	.22	.12	.08
20	2.00	.89	.50	.32
150	15.03	6.69	3.76	2.41

To illustrate:—To force 150,000,000 U. S. gallons of water per acre in one day through a 3-ft. layer of sand whose effective grain size is .40 mm., a head of water as defined above of 3.76 feet is necessary, the conditions as to temperature, etc., being as indicated.

It will be apparent that with the accumulation of arrested filth on the surface and in the body of the upper sand layers, the condition of which *c* is the numerical exponent, changes. In other words as the process of filtration proceeds, *c* tends to become less. If then it is desired to maintain a constant rate of filtration on a filter it is necessary to increase *h* in the same ratio as *c* diminishes. This indeed is what the attendant actually does in the manual operation of a commercial filter. As the *schmutzdecke* or surface layer increases, the outlet for the filtered water is opened. This is equivalent to an increase in the loss of head. Sometimes the compensating change whereby the rate of filtration is kept constant is made automatically.

Water filters are (a) slow sand or European, (b) mechanical, rapid or American and (c) intermittent. Slow sand filters operate at a rate of from 2,000,000 to 7,000,000 gallons per acre per day. The surface sand when dirty is scraped from the top of the filter, washed and replaced. Mechanical filters operate at a rate of from 125,000,000 to 150,000,000 gallons per acre per day. The accumulated surface layer of suspended matter is removed by backwashing or reversing the flow through the filter accompanied sometimes by mechanical agitation through the use of power driven rakes or compressed air. Intermittent filters are sand filters intended to treat badly smelling waters that are known to contain large quantities of organic matter. The operation is analogous to that of the intermittent sand filter for sewage, the object being to permit aeration of the sand medium between successive applications of the water to be filtered. The sand cleaning process is the same as in the slow sand filter.

Slow Sand Filters

These are concrete chambers each having sides and bottom and preferably a roof and each covering an area of about one acre. (Fig. 98.) The bottom is provided with underdrains upon which are placed successive layers of gravel or broken stone graded from coarse to fine. Upon this is laid a bed of sand 3 or 4 feet thick

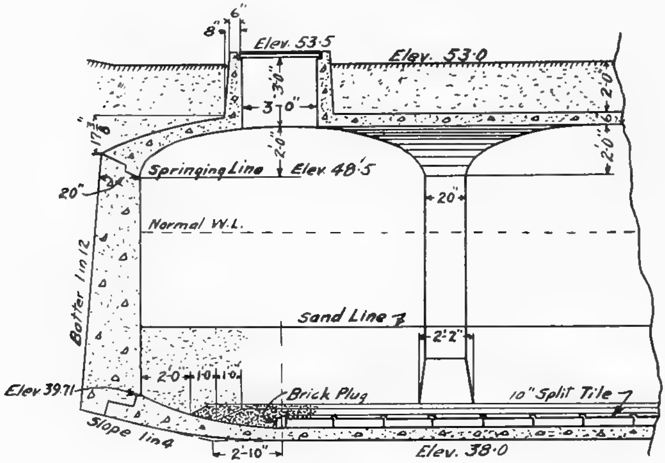

Fig. 98.—Section through slow sand filter, Toronto.

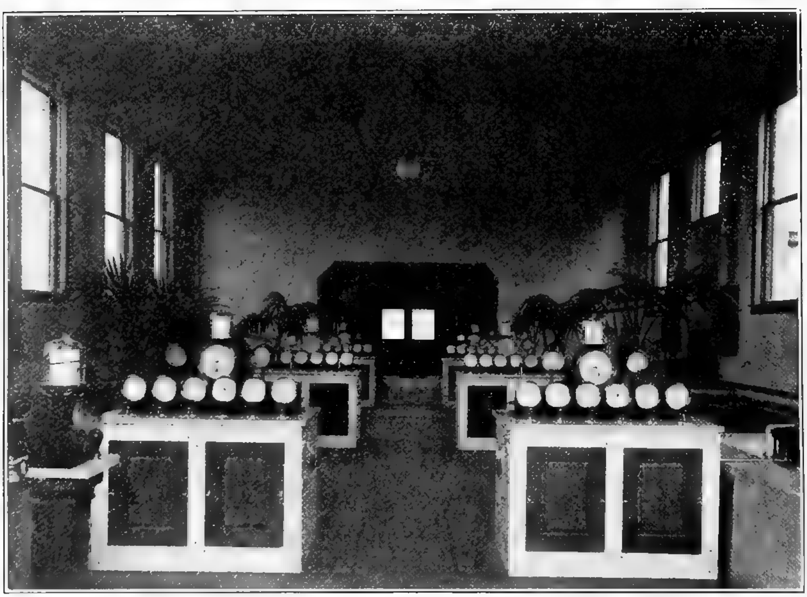

Fig. 99.—Operating gallery of gravity mechanical water filter at Saskatoon, Saskatchewan.

which constitutes the filtering medium. The raw water is run upon the filter to a depth of 3 or 4 feet. After passing through the bed the filtered water is intercepted in the underdrains and is conveyed thence to the distributing mains. When the operation of the filter indicates that washing of the surface layer is necessary, the inflow is shut off, the overlying water is permitted to drain away and the surface layer of exposed sand washed as indicated above. Preliminary treatment will, in general, be unnecessary if the turbidity of the raw water be less than 30 parts per million or its color less than 20 parts per million as measured by the American Public Health Association's Standards. If these criteria be exceeded preliminary treatment by sedimentation without or with coagulants or on rapid filters may be employed. No preliminary treatment is given the raw water at the Toronto slow sand filters constructed in 1912, the turbidity and color normally being low. If slow sand filters be covered, troubles due to ice and snow in winter and the growth of algae in summer are more easily obviated.

Mechanical Filters

Mechanical filters are of two kinds, *pressure* and *gravity.* The former are enclosed cylindrical steel tanks provided with filter sand and a collecting system beneath, through which the raw water is forced by pressure. The loss of head can be determined by attaching pressure gauges to the influent and effluent pipes and by making certain necessary corrections to the readings obtained. Gravity filters are constructed of wood or concrete, are circular or rectangular in plan and are open to the atmosphere. The strainer and collector devices are similar to those in the pressure filter. In both, however, special appliances for introducing water from below for back-washing purposes, for providing compressed air or other means for agitating the medium, for carrying away the deposited filth and for wasting the re-wash or water first filtered following the sand-washing operations must be provided. Since the mechanical or rapid filter is generally used where color or turbidity or both are moderately high, a coagulant and a coagulating basin have come to be regarded as almost necessary accessories of this type of filter. It is generally believed indeed that better results can be obtained by employing mechanical filters for waters where turbidity

exceeds 50 parts per million or color exceeds 30 parts per million. In the Ransome Drifting Sand Filter it is claimed that a coagulating basin is not necessary and that back-washing is required much less frequently than in other types since the operation of sand-washing is continuous. (Fig. 100.)

Softening

Hardness in water is due to the presence of soluble salts such as the sulphates, carbonates, chlorides and nitrates of calcium and magnesium. With soap, hard waters form insoluble precipitates. Waters containing carbonates on being sufficiently heated in boil-

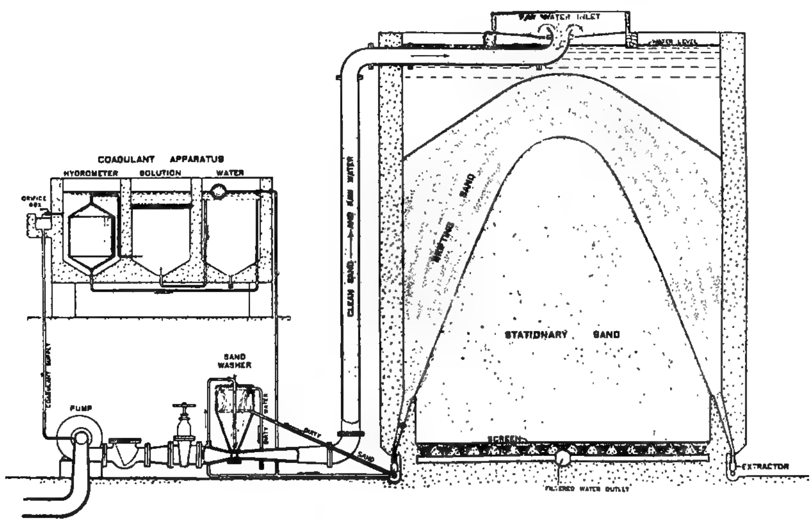

Fig. 100.—Diagram of Ransome drifting sand filter. The strength of the alum solution is controlled by the hydrometer at the upper left-hand corner of the figure.

ers, precipitate these salts forming soft scale or mud. Similarly, the sulphates produce the hard scale which adheres to the interior surfaces of the boiler and is removed only with difficulty. The two conditions are described respectively as temporary hardness and permanent hardness. Hardness is measured on this continent generally in parts of $CaCo_3$ per million. Common designations expressed on this basis are about as follows:

Very soft	0 to 10	parts per million
Soft	10 " 25	" " "
Slightly hard	25 " 50	" " "
Hard	50 " 100	" " "
Very hard	100 " 200	" " "
Excessively hard	200 " 500	" " "

The objections to hard waters are both domestic and industrial. Hard waters are ill adapted for the bath and laundry and necessitate the use of excessive quantities of soap. For dyeing, paper making, soap manufacture, tanning, etc., soft water is almost an essential. The formation of scale in steam boilers necessitates also the consumption of greater quantities of fuel than would otherwise be necessary.

A report issued in 1918 by the Administrative Board of the Greater Winnipeg Water District contains an estimate of the annual cost to the city of Greater Winnipeg of using the excessively hard ground water (476 parts per million) upon which the city was dependent prior to the completion of the Shoal Lake Project. Shoal Lake water contains about 45 parts per million of temporary hardness and it was in relation to this, at that time prospective supply, that the comparison was made. The estimate takes into account among other things the excessive quantities of soap and washing compounds rendered necessary by the use of very hard water, the fact that water fronts and gas-fired water heaters for

TABLE LXI

APPROXIMATE SAVING ON		APPROXIMATE COST	
Soaps, boiler compounds, washing fluids, etc.	$1,161,000.00	Sinking fund	$153,000.00
Water fronts (in stoves)	40,000.00	Interest	825,000.00
Water coils (in furnaces)	75,000.00	Operating charges	313,000.00
Automatic water heaters	13,000.00		$1,291,000.00
Circulating water heaters	27,600.00		
Soft water containers (cisterns)	58,000.00		
Boilers (power)	41,000.00		
Softening plants (chemicals)	7,200.00		
Fuel	500,000.00		
	$1,922,800.00		
Abstract			$1,922,800.00
			1,291,000.00
Immediate annual net saving			$ 631,800.00

domestic use have to be removed more frequently, that householders are obliged to install cisterns to save the roof water and that tubes in steam boilers have to be replaced at relatively short intervals. Against the saving accomplished through the completion of the Shoal Lake soft water project is to be placed the maintenance, interest and sinking fund charges of that undertaking. The figures are shown in Table LXI.

Expressed in another way, the saving to the citizens of the Western Canadian Metropolis due to the substitution of a soft water supply for a hard one is sufficient to construct and maintain the necessary works costing between fifteen and twenty million dollars, and to subsidize the municipality annually in addition, to the extent of $631,800.00

Methods of Softening

A common method of softening hard waters is to add some reagent which precipitates the offending salt. To precipitate carbonates, lime is often employed. To remove sulphates, chlorides and nitrates, sodium carbonate (soda ash) is used. Barium hydrate reacts similarly to lime. The American Maintenance of Way Association has prepared the accompanying Table LXII as a guide for the user of the above reagents for the removal of hardness.

TABLE LXII

QUANTITY OF PURE REAGENTS REQUIRED TO REMOVE 1 POUND OF INCRUSTING OR CORROSIVE MATTER FROM THE WATER

INCRUSTING OR CORROSIVE SUBSTANCE HELD IN SOLUTION	
Sulphuric acid	0.57 lb. lime plus 1.08 soda ash.
Free carbonic acid	1.27 lb. lime.
Calcium carbonate	0.56 lb. lime.
Calcium sulfate	0.78 lb. soda ash.
Calcium chloride	0.96 lb. soda ash.
Calcium nitrate	0.65 lb. soda ash.
Magnesium carbonate	1.33 lb. lime.
Magnesium sulfate	0.47 lb. lime plus 0.88 lb. soda ash.
Magnesium chloride	0.59 lb. lime plus 1.11 lb. soda ash.
Magnesium nitrate	0.38 lb. lime plus 0.72 lb. soda ash.
Calcium carbonate	1.71 lb. barium hydrate.
Magnesium carbonate	4.05 lb. barium hydrate.
Magnesium sulfate	1.42 lb. barium hydrate.
Calcium sulfate	1.26 lb. barium hydrate.

Permutit Process

Permutit is the commercial name of an artificial zeolite made by fusing felspar, kaolin and sodium carbonate in an electric furnace. It has the formula $NaAl\ (SiO_3)_2$. If hard water be made to filter through a granular mass of this reagent, the calcium and magnesium atoms in the salts causing hardness change place with the sodium of the permutit producing in the water a series of harmless soluble sodium salts instead of the original salts of calcium and magnesium. The altered permutit is subsequently regenerated by treating with a solution of common salt from which the necessary sodium is obtained. This operation involves no loss in the zeolite mass which may be used through an indefinite number of cycles. The field of greatest usefulness of this process seems to be in the industries.

Disinfection

The primary purpose of disinfection is the destruction of disease germ life. The agents employed are sunlight, ozone, the ultra-violet ray, and chlorine and certain of its compounds. Sulphate of copper is used for a somewhat analogous purpose. Any process of disinfection which adds nothing to water which sentimentally or actually may be objectionable is preferred to a process in which the reagent has harmful possibilities. Sunlight, the ultra-violet ray and ozone are almost ideal in this respect.

Sunlight exerts a powerful germicidal action on the upper layers of clear water, but little if it be turbid or highly colored.

Ozone, which is a nascent form of oxygen, is produced from atmospheric oxygen electrolytically. It is passed into the water or otherwise mixed with it and thus taken into solution. If the water be high in color, turbidity, or organic matter, the method is inefficient. Previous filtration in such cases is necessary anyway after which further treatment for disinfection may not be required. In comparison with other methods disinfection by ozone is expensive.

Ultra-violet rays are rays invisible to the naked eye, lying beyond the violet band in the solar spectrum. The mercury arc is particularly rich in them. They are known to have marked physiological, chemical and germicidal effects and if water be passed in thin streams within the zone of their influence, the bacteria are

quickly destroyed provided both turbidity and color are low. Matters in suspension seem to afford a protection to the microorganisms as they pass the lamp emitting the rays, in which case they may remain unharmed. Usually the water is brought under the influence of the lamp two or three times in succession in the process of disinfection. Because of its penetrability to rays of the ultra-violet quality, quartz is employed in the construction of the lamp. During

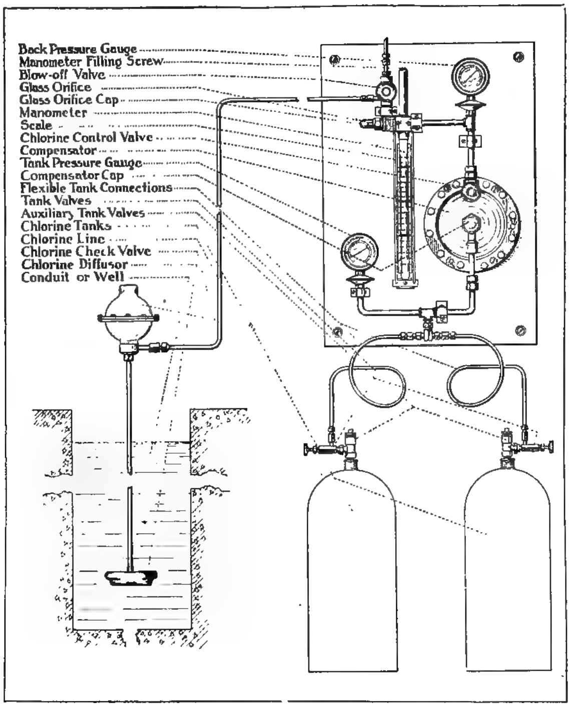

Fig. 101.—Manual control feed chlorinator.—Wallace & Tiernan Company.

the period of the war, the Canadian troops in training camps at Niagara, Ontario, were supplied with spring water for drinking purposes which was disinfected by this method.

Chlorine gas becomes liquid at ordinary temperatures under a pressure of about 100 pounds per square inch. Commercially it is compressed to a liquid at the place of manufacture and shipped in steel containers to the place of consumption. These containers when

empty are returned for refilling. Ingenious methods of supplying the reagent in known quantities to the water to be treated have been devised, some controlled manually, others automatically. Ordinarily less than .5 part per million (5 pounds per million Imperial gallons) is required for disinfection purposes. At present prices this is equivalent to $1 per million gallons. A manually controlled chlorinator capable of treating the water supply of a town of moderate size will cost about $1,000. Experience has shown that when the quantity of chlorine exceeds .6 part per million, the presence of the reagent in the water can be detected by the taste.

The advantages of chlorine as a disinfecting agent are its cleanliness, the absence of deterioration with lapse of time, the compactness of the equipment and its easy control. There is, however, some possible danger in the handling of so powerful a reagent. Liquid chlorine has of late years rather largely supplanted calcium hypochlorite for the disinfection of both water and sewage.

Copper sulphate is frequently used to prevent or destroy the growth of algae in open reservoirs. The quantity necessary varies from 0.1 to 0.4 part per million.

Costs

An Ontario city recently entered into a contract for a six million gallon per day rapid filter plant to include coagulating basin, low lift pumping station with motor driven pumps, clear water basin, pipe lines and accessories for $254,600 equivalent to $42,400 per million gallons per day capacity.

The drifting sand filter on Toronto Island has a capacity of 50 million gallons per day and was put in operation in 1917. The capital cost was $22,000 per million gallons capacity. This includes land, wharf, clear water reservoir, low lift pumps, accessories, etc. The cost of operation, administration interest, sinking fund, etc., is $12.37 per million gallons filtered. The corresponding figures for a similar but smaller plant serving another Ontario municipality are $17,000 and $14 respectively.

NOTE: Estimates of cost contained in this chapter are based on the state of the labor and material market as it existed in 1921.

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CHAPTER XVIII

MATERNAL AND INFANT MORTALITY, AND MATERNAL, INFANT AND CHILD HYGIENE

MATERNAL AND INFANT MORTALITY

Two public health problems of very considerable magnitude and of vital interest to the community are those of maternal and infant deaths. To outline the extent of these, and to indicate the necessity for physicians joining actively in organized public health efforts to lessen preventable deaths and disabilities among expectant mothers and infants and young children is the main purpose of the present chapter.

In surveys made for the Children's Bureau, United States Department of Labor, it was found that in 1916 in the United States at least 16,000 women died from conditions caused by childbirth; about 7,500 of these died from childbed fever, (puerperal septicemia) a disease known to be almost entirely preventable; and the remaining 8,500 from diseases now known to be to a great extent preventable or curable. "Physicians and statisticians agree that these figures are a great underestimate. In 1913, the death rate per 100,000 of population of all conditions caused by childbirth was a little lower than that from typhoid fever. This rate would be almost quadrupled if only the group of the population which can be affected, women of child-bearing ages, were considered. In 1913 childbirth caused more deaths among women 15 to 44 years old than any disease except tuberculosis. The death rate due to this cause is almost twice as high in the colored as in the white population." (Meigs.) Fig. 102 taken from publication 61 of the Children's Bureau, United States Department of Labor shows the rates of maternal mortality in various countries.

During the first part of the nineteenth century the death rate from puerperal septicemia was appalling. Dr. J. Whitridge Williams points out that in hospital practice at that time, the average death rate from this cause in all countries was 3 to 4 per cent,

but occasionally it was as high as 10 to 20 per cent, and sometimes even reached 50 per cent in epidemics. It is not remarkable that under such circumstances many obstetrical wards in hospitals were closed.

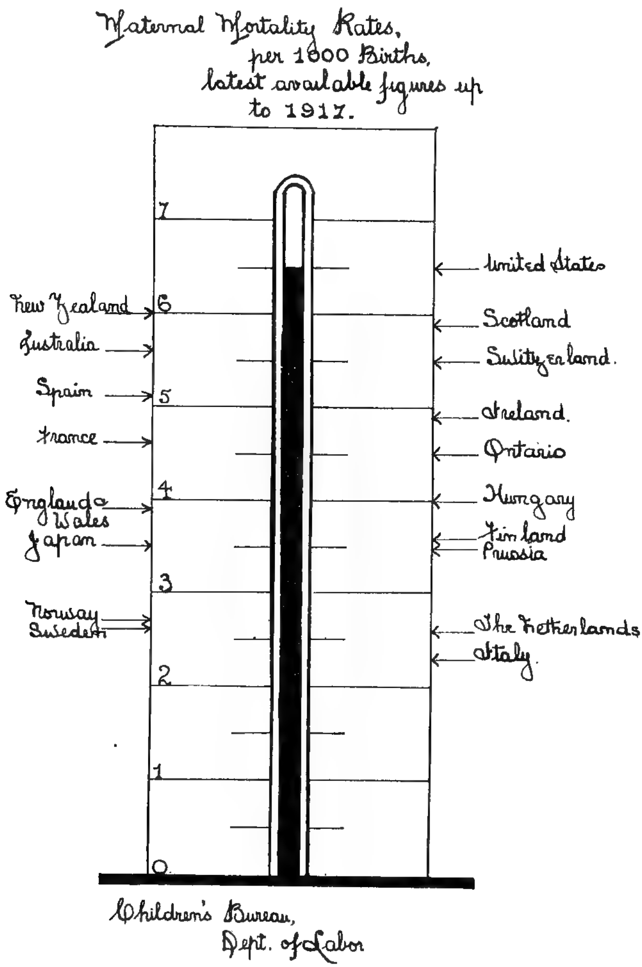

Fig. 102.

Oliver Wendell Holmes in 1843, and Semmelweis in 1847 were the first to express the opinion that the disease responsible for these deaths was the result of conditions similar to, and conveyed in the

same fashion as, wound infections. That is, infectious material was carried on the hands from one patient to another, by those responsible for the care and treatment of obstetrical cases. This idea, that puerperal septicemia or childbed fever, was really a wound infection, due to entrance of germs because of the lack of aseptic precautions at confinement, was violently opposed at first, but it is now everywhere recognized as being true.

With the introduction, first of methods of antisepsis by Lister about 1875, conditions gradually improved and Pasteur's work gave great impetus to this improvement. Better methods of disinfection, antisepsis and asepsis, were introduced into obstetrical work in hospitals, with the result, as Williams points out, that "At the present time it is safe to say that in well regulated hospitals the mortality from puerperal infection is less than 0.25 per cent. This is in contrast with the average mortality of 3 to 4 per cent observed in hospitals throughout the world prior to the introduction of antiseptic methods, and means that only 1 woman now dies as compared with 15 or 20 formerly." While it is probably true that occasional cases of puerperal septicemia develop where every care has been exercised, the results quoted by Williams indicate that by the application of the principles of personal hygiene and strict surgical asepsis, the vast majority of cases of childbed fever may be prevented.

Other cases of maternal mortality are puerperal eclampsia or albuminuria or toxemia of pregnancy. Early recognition of this permits of the application of appropriate preventive measures by physicians, and the reduction of deaths from this cause follows. Accidents of pregnancy due to obstruction, etc., are important causes of death in childbirth, and in many instances probably preventable.

In England and Wales, during the decennial period 1908-17, the average number of births was 853,516 and the number of mothers dying annually from conditions assigned to maternity was 3,867. In 1917 the number of births was 668,346 (17.8 per 1,000 of population) and the number of deaths assigned to pregnancy or confinement 2,598 (3.89 per 1,000 births). Sir George Newman in presenting these data noted, "that associated with the issue of maternity there is a burden of invalidism and suffering and incapacity which, though unrecorded in the national statistics is exerting a serious affect upon the well-being of the community." Further in

the same memorandum it is pointed out by Newman that "much of the suffering entailed in maternity, much of the damage to the life and health of women and children, would be got rid of, if women married with some knowledge of what lay before them, and if they could obtain medical advice and supervision during the time of pregnancy and motherhood. Still more would be got rid of if pregnancy and childbirth were adequately protected and safeguarded."

For some time past there has been a growing appreciation of the fact that antenatal factors were very significant in relation to infant deaths during the first month of life. That an improvement in the conditions surrounding the mother during pregnancy and confinement would probably favorably influence, not only the maternal mortality, but also the infant death rate was and is believed by many to be true. Important causes of infant mortality, such as prematurity and congenital debility, would undoubtedly be favorably modified in this way. It is, of course, evident that conditions which diminish the hazard to which the mother is subjected in childbirth will at the same time be in the interest of the child. The solution of the problems, therefore, of preventable maternal and infant deaths and disability should be attempted jointly and not separately.

The expression of maternal death rates is possible by any one of four methods. (1) Death rates per 100,000 population; (2) death rates per 100,000 women of child-bearing age; (3) death rates per 1,000 births; and (4) death rate per 1,000 live births. This last rate is the most sensitive indicator of the actual risk of childbirth in any community. Unfortunately the statistics in many countries are so inadequate that it is impossible to arrive at any definite conclusions. First, because, in some instances incomplete and incorrect returns of the causes of death are made, and second there is no method existing by which the returns may be checked or the completeness of birth registration ascertained.

However, with these reservations the following diagram gives an idea of the great importance of deaths caused by pregnancy and confinement and their relative proportion to deaths registered from typhoid fever, and diphtheria and croup, in the registration area of the United States for the years 1901-1918. This is shown in Table LXIII and Fig. 103.

TABLE LXIII

DEATHS AND DEATH RATES PER 100,000 POPULATION FROM SPECIFIED CAUSES IN THE EXPANDING DEATH REGISTRATION AREA, 1901-1918

YEAR	CAUSES OF DEATH: DIPHTHERIA AND CROUP		TYPHOID FEVER		DISEASES OF PREGNANCY AND CONFINEMENT	
	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000
Annual Average 1901-1905	9,674	29.6	10,458	32.0	4,643	14.2
Annual Average 1906-1910	10,576	22.4	12,120	25.6	7,330	15.5
1911	11,174	18.9	12,451	21.0	9,456	16.0
1912	11,013	18.2	9,987	16.5	9,035	15.0
1913	11,920	18.8	11,323	17.9	10,010	15.8
1914	11,786	17.9	10,185	15.4	10,518	15.9
1915	10,544	15.7	8,332	12.4	10,237	15.2
1916	10,367	14.5	9,510	13.3	11,642	16.3
1917	12,442	16.5	10,089	13.4	12,528	16.6
1918	11,183	13.7	10,167	12.4	18,177	22.2

TABLE LXIV

MATERNAL MORTALITY RATES PER 1,000 BIRTHS
Children's Bureau, U. S. Department of Labor

COUNTRY	1914	1915	1916	1917	1918	1919
Italy	2.4	2.2				
Sweden	2.6	2.9				
The Netherlands	2.1	2.5	2.6	2.5	3.0	3.4
Norway		2.7				
Prussia	3.5					
Japan	3.5	3.6	3.5			
Finland			3.6			
England and Wales	4.2	4.2	4.1	3.9	3.8	4.4
Hungary		4.0				
Ireland	5.0	5.4	5.5	4.9	4.8	
Spain	5.3	5.2				
Switzerland	5.3	5.5				
Australia	4.6	4.3	5.3	5.6	2.7	
New Zealand*	4.2	4.7	5.9	6.0	5.2	5.1
United States (Birth Reg. Area)		6.1	6.2	6.6	9.2	7.4
Scotland	6.0	6.1	5.7	5.9	7.0	6.2

*Beginning with 1916 special inquiries sent to physicians reporting deaths assigned to ill-defined causes have resulted in more accurate certificates of death for puerperal causes.

Table LXIV shows the number of maternal deaths per 1,000 live births in various countries for the years 1914-1919.

The relative importance of puerperal septicemia as a cause of maternal deaths in the United States Birth Registration Area for the years 1915-1919 is shown in Table LXV.

In England and Wales, where 75 per cent of the obstetrical work is done by midwives, regulation of these is provided for by law. In 1900 the maternal rate was 4.65 per 1,000 live births of which 2.24, or 48 per cent, of the total were due to puerperal septicemia. By

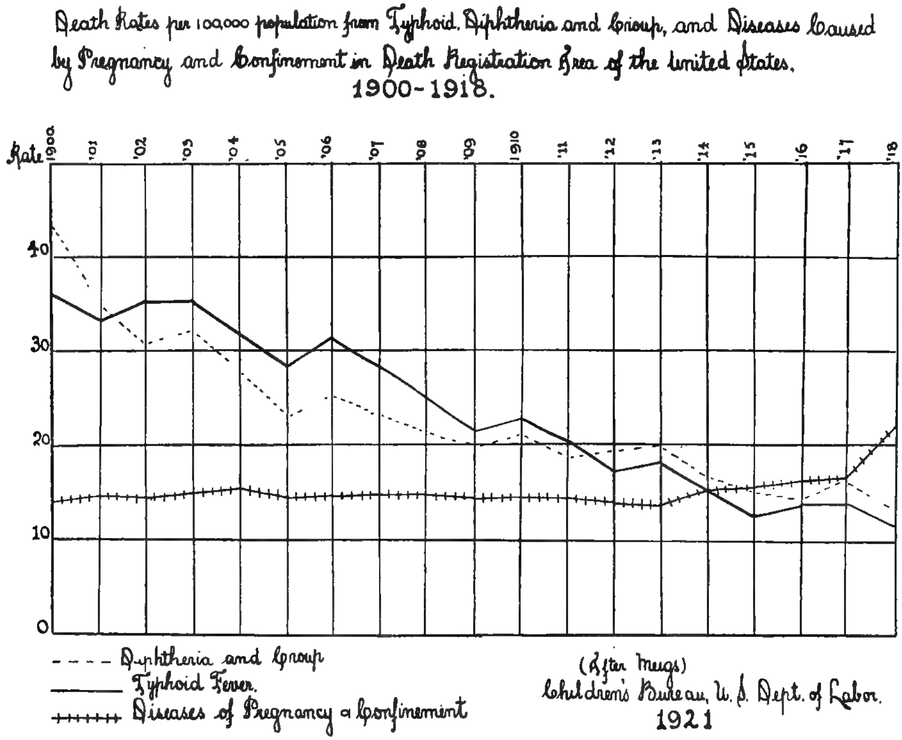

Fig. 103.

1910, as a result of improvements in midwifery practice, the maternal mortality was reduced to 3.69 per 1,000 live births of which 1.44, or 39 per cent, were due to puerperal septicemia. During the years 1911-15 the maternal deaths, including those due to nephritis and albuminuria were 4.2 per 1,000 live births, and puerperal septicemia was the cause of death in 33 per cent of cases (quoted by McIlwraith). Deaths in the puerperal state in the International

TABLE LXV

MATERNAL MORTALITY RATE, 1915-1919, U. S. BIRTH REGISTRATION AREA[a]

YEAR	DEATHS FROM PUERPERAL CAUSES PER 1,000 LIVE BIRTHS ALL PUERPERAL CAUSES	PUERPERAL SEPTICEMIA	ALL OTHER PUERPERAL CAUSES
1915	6.1	2.4	3.7
1916	6.2	2.5	3.7
1917	6.6	2.7	3.9
1918[b]	9.2	2.6	6.6
1919[c]	7.4	2.5	4.9

[a]The birth registration area included 31.0 per cent of the estimated population of continental United States in 1915, 32.4 per cent in 1916, 53.1 per cent in 1917 and 1918.
[b]Deaths from two or more joint causes are ascribed to a single cause in accordance with definite rules, as published in Joint Causes of Death, U. S. Bureau of the Census. Deaths from influenza and a puerperal cause are ascribed, according to these rules, to the puerperal cause.
[c]Exclusive of Rhode Island.

Classification of Diseases and Causes of Death are included under 6 heads. The relative number under each of these, registered from year to year, varies of course, in different communities; however, Table LXVI will give an idea of the relative number of these, given as

TABLE LXVI

MATERNAL DEATHS—PROVINCE OF ONTARIO

	1917	1918	1919
Estimated Population	2,769,850	2,798,970	2,837,425
Live Births:	62,666	64,729	62,774
Ratio per 1,000:	22.6	23.1	22.1
Maternal Deaths:	328	298	284
Rate per 1,000 *Live Births*	5.4	4.6	4.5
Assigned Causes of Death:			
Accidents of pregnancy	59	43	55
Puerperal hemorrhage	22	26	40
Other accidents of labor	57	63	42
Puerperal septicemia	107	92	85
Puerperal albuminuria and convulsions	80	70	57
Puerperal phlegmasias embolus, sudden death, etc.	3	4	5

causes of death in the puerperal state. They are taken from the Report of the Registrar General of the Province of Ontario for the years 1917, 1918 and 1919.

According to McIlwraith the maternal mortality for the period 1909-1918 inclusive, in Ontario was 5.4 per 1,000 live births and puerperal septicemia was the cause in 1.88 or 35 per cent of all

cases. The important feature of these statistics is the importance of accidents of labor, puerperal septicemia and puerperal albuminuria as a cause of death in maternity. These, as has been pointed out, are largely preventable. While it is true that hospital epidemics of childbed fever are things of the past, there is still an excessive incidence of deaths of mothers in pregnancy and confinement.

The explanation of the above facts is probably two-fold. In the first place it is estimated that about 80 per cent of pregnant women do not consult a physician until they are about to be confined. And a second important reason is the fact that a large number of confinements take place in surroundings and under conditions which are prejudicial to the health and welfare of both mother and child. Usually it is true that confinements can be more satisfactorily conducted in a hospital than elsewhere. That an exceedingly low mortality rate among obstetrical cases confined at home is possible, however, when proper service is provided, is indicated by the statement of Chapin that at the Boston Lying-in Hospital up to 1919, the maternal mortality among the last 5,000 out-patients was 0.04 per cent. Where for any reason, hospital facilities are not accessible or the patient will not take advantage thereof, it is most essential that labor be conducted under conditions as nearly as possible comparable to those exacted in an obstetrical service of a properly organized hospital. In addition, if preventable deaths in childbirth are to be diminished in number it is necessary to emphasize that suitable measures must be adopted early in pregnancy.

With this in view there have been established in nearly all large centers so-called antenatal clinics. Their purpose is primarily educational. Through demonstration, the necessity for, and the value of, supervision throughout the period of pregnancy is made clear to expectant mothers. Since such a small percentage of pregnant women now place themselves under the care of a physician, the value of these clinics is obvious. A certain proportion of women will, very soon, after it is known that they are pregnant, consult their own physician and remain under his direction until after confinement. This is as it should be. But many others must be taught the advantages of antenatal supervision.

Public health nurses have an opportunity of advocating the wisdom of such a procedure whenever the occasion presents. In a certain number of cases it will be impossible for expectant mothers

to obtain this supervision at their own expense because of financial considerations; for such the State very often does, and everywhere should, make provision. In large cities a great many mothers go to a hospital during confinement, and many others have a physician and district visiting nurse. Among all such cases, systematic antenatal supervision is possible.

In connection with antenatal clinics, it is as a rule customary at the patient's first visit to request the name of her physician. Unless she states that she intends entering the public ward of a general hospital, the physician is then communicated with, and reports of the results of the examination are sent to him. In addition, the records of routine observation made at the clinic are placed at the disposal of the physician.

The procedure is to request the patient to come once a month, if normal, after the first visit. She is visited by a public health nurse, or social worker, at least as often as that, if she does not come to the clinic.

The average patient at many antenatal clinics comes for the first time about the fifth or sixth month of pregnancy. Frequently it is desirable to see the patient for the first time earlier in pregnancy. At the initial visit the history is taken, an examination made, but the first pelvic examination is not made before the seventh month unless there is some reason why it should be made earlier.

A copy of the record form used at the Antenatal Clinic at the Toronto General Hospital indicates the scope and character of the examination, and is shown on pages 502-504.

A Wassermann examination should be made of the blood of the expectant mother before confinement, and of the baby as soon as convenient after birth, in every instance where the history or clinical symptoms suggest that it is desirable. In many obstetrical services in general hospitals it is done as a routine.

In those cases attending the clinic, where albumin is found in the urine or the blood pressure is above normal, the patients usually enter the hospital, are kept in bed for a week or ten days, put on a milk diet, and magnesium sulphate administered. In this way appropriate preventive measures greatly lessen the chances of the development of eclampsia. In the same way pelvic anomalies can be discovered early and proper treatment instituted. In connection with antenatal care, much educational work is necessary if obstet-

rical work in the community is being done by unskilled midwives, or others not properly trained in obstetrics. Whitridge Williams has pointed out "that the public must be taught that the conduct of labor, complicated by a moderate degree of pelvic contraction, is quite as serious as a case of appendicitis, and that its proper management requires the highest degree of judgment and skill, while eclampsia or placenta previa are even more serious."

In certain communities, form letters are sent to all expectant mothers, or all women after marriage, detailing the essential facts relating to antenatal care. It is pointed out that puerperal deaths, the result of eclampsia and other causes are reduced, that fewer stillbirths result, and that the probability of a strong healthy baby being born, is greater, where the expectant mother has been under supervision during the period of pregnancy. Physicians should encourage patients to consider that antenatal supervision is essential. Repeated urine examinations are made in order that the first indication of abnormality in renal function, presence of albumin, etc., may be detected at once. In addition pelvic measurements are taken and a general physical examination made, including an estimation of systolic and diastolic blood pressure.

In states and provinces where hospital facilities are meagre and medical and nursing service both scarce and often difficult to secure, municipal hospitals are being erected where care and treatment during confinement is provided. The Provinces of Saskatchewan and Alberta have been pioneers in this field. These small hospitals of 10 to 15 beds in isolated rural communities make it possible for women to receive adequate attention in labor; and if necessary, the expense of hospital care and physician's services are provided in the form of a maternity grant.

It is certain that all are agreed that maternity should be made as safe as possible; that expectant mothers should be urged to abstain from heavy and arduous work for an appropriate period before and after confinement; and that every opportunity should be provided for the mother, if at all possible, to breast-feed her infant.

A table prepared to show the results in three groups of obstetrical cases in the Obstetrical Wards of the Toronto General Hospital is very instructive in this particular. The first group is that of a series of semiprivate patients among whom antenatal supervision was not

provided, and two groups of public-ward cases one supervised and the other not. The results are shown in Table LXVII.

TABLE LXVII

RECORD IN OBSTETRICAL CASES, TORONTO GENERAL HOSPITAL FOR TWO YEAR PERIOD. TO SHOW THE INFLUENCE OF ANTENATAL SUPERVISION, (after Gordon Gallie and J. W. S. McCullough)

	SEMI-PRIVATE CASES (not supervised)	PUBLIC WARD CASES (not supervised)	PUBLIC WARD CASES (supervised)
No. of Cases	1198	505	461
Deaths of Mothers	10 (0.8%)	18 (3.5%)	2 (0.4%)
Stillbirths	45 (4.0%)	40 (7.9%)	6 (1.3%)
Eclampsia (convulsions)	20 (1.6%)	16 (3.0%)	2 (0.4%)

From this it will be seen that maternal deaths, stillbirths and eclampsia are all favorably affected in incidence by suitable antenatal care.

In the study of 200 cases of stillbirths, which occurred in the Toronto General Hospital between 1914 and 1920 Gallie found that it was possible in 146 of the histories to ascertain the probable cause. Only 6 of the 146 mothers had antenatal care, in this series. The causes of stillbirths were classified as follows:

(1) *Conditions in the mother to which stillbirth could be attributed:*

Placenta previas	16		
Accidental hemorrhage	7		
Labor pneumonia	1		
Occluded Os	1		
Eclampsia	4		
Pre-eclampsia, toxemia	16		
Syphilis	7	Total	62

Gallie concludes that 25 of the 62 stillbirths in this group would have been prevented by suitable antenatal supervision. Certainly a large percentage of the cases of eclampsia, toxemia and syphilis are preventable causes of stillbirths.

(2) *Stillbirths in which there were no apparent abnormalities in the mother:*

Monstrosities	12		
Macerated fetus, for which no cause was found	8		
Habitual death of fetus	2	Total	22

BURNSIDE OBSTETRICAL DEPARTMENT, T. G. H.
TORONTO

GENERAL HISTORY

Complications..............................

....

....

....

....

Application
- History No. ....
- Diagnosis ....
- Date ...., 19.......
- No. ....
- Date of Birth ....

Name .... Nationality .... Age........ Para. ......

Address .... M. S. W. Occupation..............................

Family History ....

Personal History of Rickets, Syphilis, Gonorrhea, Leucorrhea, Pelvic Trouble, Heart, Lungs, Kidneys

Menstrual History, Type .... Day, Duration .... Days, Amount..........

Pain .... Age at Puberty ....

Last Menstruation {Sure / Doubtful} First day of...................., 19....... {Normal / Abnormal}

Labor Expected ...., 19......

Previous Pregnancies, Number .... Vomiting, Headache, Edema.

Labors ....Miscarriages, No. ....

Present Pregnancy, Vomiting, Headache, Edema, etc. .... General Condition

Children, Weight at birth.......... Health...............No. Living......... Cause of Death....................

ANTEPARTUM EXAMINATION, EXTERNAL

Date.................... Height....................... Weight....................... B. P.......................

Maternal Heart................................ Lungs............................. Edema...................

BREASTS	ABDOMEN	UTERUS	FETUS
Gland Tissue	Form	Contractions	Presenting Pt. { In / above / Below } Brim
Secretion	Fat	Uterine Murmur	Position
Nipples	Abdominal Ballottement	Size	Heart { Rapidity / Position ....

MEASUREMENTS:

Height from Symphysis to Umbilicus..................cm. Fundus.............cm. Ensiform............cm.

Between Spines..................cm. Between Crests..............cm. External Conjugate..............cm.

INTERNAL EXAMINATION

VAGINA	CERVIX	UTERUS
Ostium Pigmentation	Position	Situation ....
Veins	Softening	Mobility ....
Perineum { Intact / Old Laceration / Cystocele / Rectocele	External Os	Consistency ....
Size	Internal Os	Ballottement ....
Secretion	Laceration	

MEASUREMENTS:

Pubic Arch....................cm. Depth of Symphysis.............cm. Diagonal Conjugate...........cm.

Transverse Diameter of Outlet.....................cm. Ant. Posterior Diameter Outlet ....cm.

True Conjugate....................cm.

Remarks ....

Examined by ....

LATER EXAMINATIONS

Date	....	....	....
Fundus	....	....	....
Presenting Part	....	....	....
Fetal Heart	....	....	....

URINALYSIS

Date									
Quantity									
Reaction									
Sp. Gr.									
Albumin									
Microscopic									
Nitrogen Co-efficient									
Urea									

This group includes those in which developmental anomalies, the causes of which are at present unknown, were responsible. Among this group little can be done at present except to improve the general health of the expectant mother, where such is necessary.

(3) *Stillbirths in mothers who were allowed to go beyond full term with resultant dystocia due to disproportion between the size of the fetal head and the maternal pelvis:—12.*

"These are practically all preventable."

(4) *This group includes cases of injury to the child at birth and accidents during confinement:*

Breech version and extractions	12	
Face and brow presentation	6	
Forceps	14	
Ruptured uterus	2	
Prolapsed cord	6	
Spontaneous delivery with basal hemorrhage	6	Total........ 46

The comment by the author of the paper on this group is as follows: "Attention is here once more drawn to the fact that the operation of forceps, especially high forceps, is not one to be lightly considered. Second stage, low forceps is usually a safe procedure and is quite justified under certain well-defined conditions. High forceps is one of the most abused operations there is, and is usually accompanied by disastrous results for the mother and child."

(5) *A group of cases of stillbirth due to ill defined causes...... 7*

Of the total here analyzed it is believed that 37 or 25 per cent were preventable. Clifton Edgar in an analysis of 500 stillbirths in New York concluded that 20 per cent might have been prevented by adequate antenatal care.

Gallie concludes his observations in regard to the need for more widespread antenatal work as follows: "The sooner medical practitioners get over the idea that when they have booked their patient and made a vaginal examination and a urinalysis, that they are through with her until labor commences, the safer it will be for mother and child. Frequent consultations—once a month at least; frequent urinalysis—once every two weeks, at least; a record of blood pressure; careful pelvimetry; and instruction of the patient as to her mode of life and to the significance of certain danger signals; greater care; greater watchfulness; these things will count

more in the reduction of stillbirth rate (and maternal mortality rate, also) than manual dexterity and skill in the use of forceps."

The incidence of stillbirths is of much importance. At the present the total number of these registered is probably considerably below the actual number. In many communities these amount to from 3 to 5 per cent of the live births, recorded. In conclusion, then, the following are prime essentials in any campaign to reduce maternal mortality, the result of conditions arising during pregnancy or in childbirth.

(1) *Proper antenatal supervision* including:

- (a) Physical examinations periodically; pelvic measurements and internal examination before seventh month of pregnancy.
- (b) Blood pressure determinations—as part of the first and subsequent examinations.
- (c) Urine examination at regular intervals throughout pregnancy.
- (d) Wassermann test if necessary.
- (e) Education of the expectant mother in the essentials of personal hygiene including food, clothing, exercise, rest, etc.

(2) Adequate and satisfactory medical and nursing care during confinement. Provision for at least ten days' to two weeks' rest in bed after normal delivery.

(3) Social measures providing for unmarried mothers—regulation of women during pregnancy, providing allowances where necessary, etc.

INFANT MORTALITY

It has been recently emphasized that about 20 per cent of all public health work centers about mother and child. This; no doubt, accounts for the growing appreciation of the importance of child hygiene in all public health efforts at present undertaken by the community.

As in other fields of public health so in this, it is necessary first to endeavor to ascertain the extent and character of the problem in terms of the numbers of deaths, and the volume of sickness and disability, in order that preventive measures may be considered.

Infant deaths are, as a rule, expressed as so many deaths in children under one year of age, per 1,000 living births, where birth and

death registration is sufficiently complete actually to indicate the real condition of affairs. In this regard interesting and profitable comparisons are possible. The difficulty is that while death registrations may be nearly complete, birth registrations may be much less so. However, realizing this possible source of error, a review of the data of different communities is very instructive.

Birth and death registration has been carried out systematically in England and Wales for many decades, and the infant mortality rate for a very considerable period of time is available. Table LXVIII reflects the steady reduction in infant deaths in England and Wales during the past four decades.

TABLE LXVIII

INFANT MORTALITY—ENGLAND AND WALES

Deaths of Infants Under One Year.

1881-1919.

YEAR	DEATHS UNDER 1 YEAR PER 1,000 BIRTHS	YEAR	DEATHS UNDER 1 YEAR PER 1,000 BIRTHS
1881-1885	139	1909	109
1886-1890	145	1910	105
1891-1895	151	1911	130
1896-1900	156	1912	95
1901-1905	138	1913	108
1902	133	1914	105
1903	132	1915	110
1904	145	1916	91
1905	128	1917	96
1906	132	1918	97
1907	118	1919	89
1908	120	1920	80

In the United States, the registration area in 1918, included six New England States (Maine, Massachusetts, Vermont, New Hampshire, Connecticut and Rhode Island) and Indiana, Kansas, Kentucky, Maryland, Michigan, Minnesota, New York, North Carolina, Ohio, Pennsylvania, Utah, Virginia, Washington, Wisconsin and the District of Columbia. The estimated population was 55,813,339, or about 53 per cent of the total population of the United States for that year. The total number of infants born alive was 1,363,649, a birth rate of 24.4 per 1,000 of population. The mortality rate for infants under one year of age averaged 101 per 1,000 living births. The infant mortality in the same area, in 1917, was 94, and in 1919, 87 per 1,000 live births.

TABLE LXIX

BIRTHS AND INFANT MORTALITY, 1918, REGISTRATION AREA UNITED STATES

AREA	NO. OF BIRTHS	DEATHS OF INFANTS UNDER 1 YEAR OF AGE PER 1,000 LIVING BIRTHS
Registration area total	1,363,649	101
White	1,288,711	97
Colored	74,938	161
STATES		
Connecticut	36,971	107
Indiana	64,385	87
Kansas	39,117	80
Kentucky	62,338	93
White	58,373	87
Colored	3,965	191
Maine	16,798	101
Maryland	34,113	140
White	27,960	124
Colored	6,153	215
Massachusetts	95,640	113
Michigan	91,011	89
Minnesota	55,941	71
New Hampshire	9,642	113
New York	242,155	97
North Carolina	75,525	102
White	52,143	85
Colored	23,382	140
Ohio	124,586	94
Pennsylvania	220,170	129
Rhode Island	15,499	126
Utah	14,478	64
Vermont	7,507	93
Virginia	63,062	103
White	43,637	86
Colored	19,425	141
Washington	25,682	69
Wisconsin	60,867	79
CITIES		
Connecticut		
Bridgeport	4,910	100
New Haven	4,869	90
District of Columbia		
Washington, total	8,162	112
White	6,021	85
Colored	2,141	188
Indiana		
Indianapolis	6,196	93
Kentucky		
Louisville	4,368	112
White	3,898	96
Colored	470	251

TABLE LXIX—CONTINUED

BIRTHS AND INFANT MORTALITY, 1918, REGISTRATION AREA UNITED STATES

AREA	NO. OF BIRTHS	DEATHS OF INFANTS UNDER 1 YEAR OF AGE PER 1,000 LIVING BIRTHS
CITIES		
Maryland:		
Baltimore	15,143	149
White	12,819	137
Colored	2,324	215
Massachusetts:		
Boston	20,062	115
Cambridge	2,672	107
Fall River	3,646	180
Lowell	3,286	159
Worcester	5,238	97
Michigan:		
Detroit	27,036	100
Grand Rapids	2,836	86
Minnesota:		
Minneapolis	8,704	73
St. Paul	5,155	87
New York:		
Albany	2,153	115
Buffalo	13,989	121
New York	137,649	92
Rochester	6,855	92
Syracuse	4,352	119
Ohio:		
Cincinnati	7,913	104
Cleveland	20,699	98
Columbus	4,464	101
Dayton	3,282	87
Toledo	5,524	94
Pennsylvania:		
Philadelphia	43,408	124
Pittsburgh	15,875	139
Scranton	3,139	141
Rhode Island:		
Providence	6,384	123
Virginia:		
Richmond	3,840	147
White	2,625	105
Colored	1,215	236
Washington:		
Seattle	5,910	61
Spokane	2,194	77
Wisconsin:		
Milwaukee	11,090	106

The rate varied greatly in this area in 1918, for the two sexes. The rate for the male was 111, and for the female infants 90.4—the rate among males being nearly 23 per cent greater than for female infants. There were also considerable differences depending on race or nationality. The lowest rate 71.4 was found in infants with mothers born in the Scandinavian countries, Denmark, Norway, and Sweden; and the highest, for infants with mothers born in Poland, 172.4 per 1,000 births. The rate for negro children was 163 per 1,000 compared with 101 for children of all races and nationalities.

TABLE LXX

INFANT MORTALITY RATES FOR CERTAIN FOREIGN COUNTRIES AND THE UNITED STATES

Children's Bureau, Department of Labor

COUNTRY AND YEAR	INFANT MORTALITY
Chili (1919)	306
Hungary (1915)	264
Bavaria (1918)	203
Spain (1918)	183
Japan (1917)	173
Germany (1918)	154
Prussia (1918)	148
Italy (1915)	147
Quebec (1917)	138
France (77 Depts., 1919)	119
Finland (1917)	118
Scotland (1919)	102
Uruguay (1919)	101
Ontario (1919)	95.5
Denmark (1919)	92
England and Wales (1919)	89
Ireland (1919)	88
Switzerland (1918)	88
United States (Birth Reg. Area, 1919)	87
Netherlands (1919)	84
Sweden (1915)	76
Australia (1919)	69
Norway (1917)	54
New Zealand (1919)	45

The rates in the whole registration area for 1918, also for the various States and Cities of 100,000 population is shown in Table LXIX, from Weekly Public Health Reports, United States Public Health Service, May 20th, 1920.

There is a great variation in infant mortality rates in different

TABLE LXXI

INFANT MORTALITY RATES—VARIOUS COUNTRIES[a]

COUNTRY	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Hungary	194	207	186	201	195	204				
Chili	267	333	287	286	255	254	241	269	255	306
Austria	189	207	181	190						
Japan[b]	161	158	154	152	159	160	170	173		
Spain	149	162	137	155	152	152	147	155	183	
Germany	162	192	147	151	164	154	136	155	154	
Italy	142	153	130	137	130	147				
France	111	157	104	109	109[c]	141[c]	122[c]	123[c]	138[c]	119[c]
Finland	118	114	109	113	104	110	110	118		
Scotland	108	112	105	110	111	126	97	107	100	102
The Netherlands	108	137	87	91	95	87	85	87	93	84
England and Wales	105	130	95	108	105	110	91	96	97	89
Ireland	95	94	86	97	87	92	83	88	86	88
United States (Birth Reg. Area)						100	101	94	101	87
Switzerland	105	123	94	96	93	90	78	79	88	
Sweden	75	72	71	70	73	76				
Denmark	102	106	93	94	98	95	100	99	74	92
Australia	75	68	72	72	71	68	70	56	59	69
Norway	68	65	68	65	68	68	64	54		
New Zealand	68	56	51	59	51	50	51	48	48	45
Quebec (Canada)	178	186	161	168	161	153	165	138		
Ontario (Canada)	119	114	110	118	103	102	107	92	98	95
Bavaria	202	223	177	182	193	194	190	186	203	
Prussia	157	188	146	150	164	153	146	153	148	
Uruguay	111	109	118	93	95	111	124	107	110	101

[a]The figures in this table were taken from the statistical reports of the various countries when possible, or computed from figures from Annuaire International de Statistique Tome II (1917)

[b]These rates were computed from figures from Annuaire International de Statistique Tome V (1921)

[c]Without the invaded departments.

(Children's Bureau, U. S. Department of Labor, May, 1921.)

communities, and for many years New Zealand and certain of the Scandinavian countries have had a very excellent record in this respect. Table LXX shows the infant death rate in various countries for the years 1910 to 1919 inclusive.

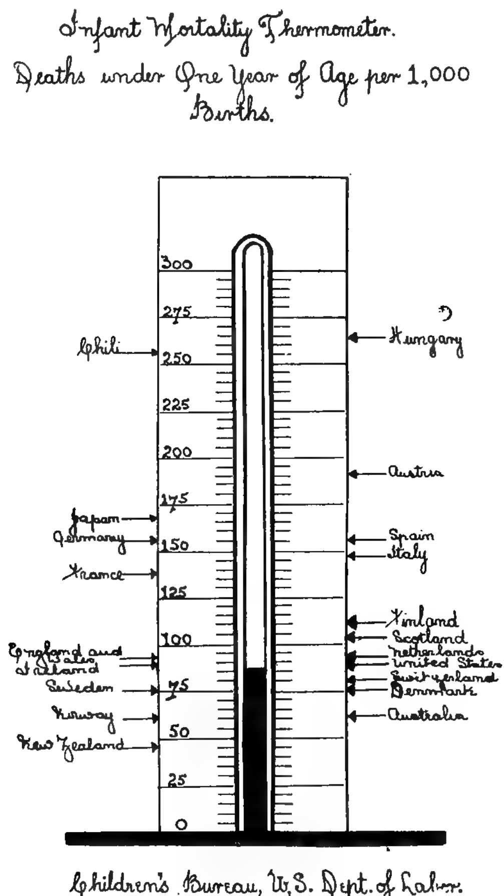

Fig. 104.

Fig. 104 illustrates the rates in 1919 in certain of these countries. The infant death rate in New Zealand is the lowest of any community in the world. A steady decline in the rate in deaths due to tuberculosis, and other communicable diseases, and convulsions began about 1875. Between 1875 and 1905 there was a slight fall in

TABLE LXXII

DISEASE IN INFANT MORTALITY RATES, BY CAUSES OF DEATH, NEW ZEALAND, 1872-1918

Deaths under one year of age per 1,000 births.

PERIOD	EPIDEMIC DISEASES	TUBERCULOSIS	VENEREAL DISEASES	ENCEPHALITIS MENINGITIS, AND INFANTILE PARALYSIS	RESPIRATORY DISEASES	GASTRIC INTESTINAL DISEASES	INFANTILE CONVULSIONS	MALFORMATIONS	DISEASES OF EARLY INFANCY	EXTERNAL	OTHER DEFINED	ILL-DEFINED
1872-4	13.9	4.7	0.2	1.8	12.5	22.9	10.0	0.7	23.6	1.4	10.5	2.3
1875-9	8.7	5.7	0.4	1.6	12.4	22.4	8.2	1.7	24.2	2.0	11.9	1.1
1880-4	7.9	5.0	0.3	1.3	12.2	18.1	8.0	1.4	23.1	1.9	12.0	0.3
1885-9	6.3	4.2	0.4	1.3	10.8	19.9	6.7	1.2	25.1	1.8	7.4	0.4
1890-4	10.2	3.3	0.5	1.3	11.3	17.0	6.4	1.2	25.0	1.8	7.7	0.2
1895-9	5.7	3.0	0.6	1.3	10.4	18.7	6.4	1.6	26.1	2.0	7.0	0.2
1900-4	5.2	1.8	0.5	1.2	10.0	16.0	4.5	1.6	27.5	2.2	6.1	6.1
1905-9	3.9	1.4	0.5	1.3	8.4	15.5	3.6	1.4	26.6	2.0	4.8	0.1
1910-14	2.4	0.9	0.4	1.4	6.1	10.0	2.5	3.0	27.0	1.0	2.8	0.1
1915-18	2.9	0.3	0.4	1.2	4.6	5.5	2.2	4.0	25.2	0.5	2.3	0.1

TABLE LXXIII

COMPARATIVE INFANT MORTALITY RATES BY CAUSE OF DEATH, NEW ZEALAND AND UNITED STATES BIRTH REGISTRATION AREA, 1918.

CAUSE OF DEATH	NEW ZEALAND 1918	U. S. BIRTH REGISTRATION AREA 1917	1918
All causes	48.4	93.8	100.8
Gastric and intestinal diseases	2.7	21.2	20.4
Respiratory diseases	3.9	14.8	16.0
Malformation	3.2	6.3	6.5
Diseases of early infancy	27.3	31.8	32.8
"Epidemic diseases"*	4.7	8.6	14.8
Ill-defined	....	2.9	2.9
All other	6.6	8.3	7.7

*Includes tuberculosis and syphilis.

the death rate from diseases of the gastrointestinal and respiratory systems. Since 1905, however, the death rate from gastrointestinal diseases had been reduced to one-third of its former size, and that from respiratory diseases, cut in half. The mortality from diseases of early infancy has also decreased slightly. Tables LXXII and LXXIII show the infant mortality rates in New Zealand by periods, from 1872 to 1918.

In the Province of Ontario for the decade 1910-1919 the infant deaths in cities, towns and rural municipalities have been tabulated; and Table LXXIV is taken from the Reports of the Registrar-General of that Province.

TABLE LXXIV

INFANT MORTALITY, PROVINCE OF ONTARIO, 1910-1919

YEAR	DEATHS 0-1 PER 1,000 BIRTHS, PROVINCE	CITIES AND TOWNS	% WHICH OCCUR IN URBAN MUNICIPALITIES	% WHICH OCCUR IN RURAL MUNICIPALITIES	DEATHS 0-1 (EXCLUDING DIARRHEA AND ENTERITIS) PER 1,000 BIRTHS
1910	119.4	164.9	51.0	49.0	97.0
1911	114.4	147.6	53.3	46.7	93.4
1912	110.3	138.3	57.2	42.8	93.6
1913	117.6	141.1	57.7	42.3	90.5
1914	103.2	117.9	56.3	43.7	86.9
1915	102.0	112.7	51.3	48.7	87.1
1916	107.2	123.2	55.6	44.4	93.0
1917	92.1	101.3	54.3	45.7	83.3
1918	98.5	114.7	56.0	44.0	87.8
1919	95.5	109.9	57.0	43.0	82.0

Of 34,010 deaths registered in Ontario in 1919, 7,849, or 17.6 per cent, were of infants and children under five years of age. The accompanying diagram (Fig. 105) from the Report of the Registrar-General of Ontario is a comparison of the infant death rate in urban and rural areas, and both are contrasted with the total provincial rate. In addition, the significance of diarrhea and enteritis as a cause of infant deaths is also emphasized.

INFANT MORTALITY, DEATHS OF INFANTS UNDER 1 YEAR PER 1000 LIVE BIRTHS

Fig. 105.

The estimated population of this Province, in 1919, was 2,837,425. The total births were 62,774, a ratio of 22.1 per 1,000 of population, the number of deaths of infants under one year was 5,999, a rate of 95.5 per 1,000 live births. The total number of stillbirths registered was 2,463.

The causes of stillbirths and deaths in early infancy are not yet as clearly understood as is desirable. By many syphilis is held to be

a very important cause, both of stillbirths and deaths in the first four weeks of life. An analysis of the assigned cause of 200 stillbirths in Toronto General Hospital has already been given. Syphilis there is not so important a factor as it appears to be in certain other communities. Whitridge Williams found that syphilis was responsible for 14 per cent of fetal deaths among white women admitted to the Obstetrical Ward of the Johns Hopkins Hospital. Brend, in a study of infant mortality in Great Britain, concludes that this figure is probably a close approximation to the actual percentage. The same writer also believes that syphilis is more important as a cause of stillbirths than of infant deaths.

The International Classification of Diseases and Causes of Death makes it possible to divide the factors underlying infant mortality, into definite groups as follows:

(1) Stillbirths.

(2) Infant deaths due to development conditions (Brend's first type) including:
- (a) Prematurity.
- (b) Congenital debility and marasmus.
- (c) Icterus, sclerema, etc.

(3) Infant deaths due to respiratory infections including acute bronchitis, bronchopneumonia and pneumonia.

(4) Infant deaths due to the gastrointestinal disorders—the chief of which is *diarrhea and enteritis.*

(5) Infant deaths due to other communicable diseases—chiefly *measles, whooping cough and diphtheria.*

The large percentage of deaths due to prematurity, congenital debility, etc., occur during the first four weeks of life. This group, too, is a very important one and frequently is responsible for from 30 to 35 per cent of deaths recorded in the Registrar-General's Reports during the first year of life. As Leonard Findlay has pointed out, in his study of the Glasgow experience in infant mortality, there is a great need for a more thorough study of this group of causes, especially of prematurity and "congenital debility," so-called.

The percentage of infant deaths in different months during the first year of life is shown in Table LXXV, from the Reports of the Registrar-General for England and Wales.

TABLE LXXV

INFANT MORTALITY, 1905-1914, ENGLAND AND WALES
DEATHS REGISTERED AT DIFFERENT PERIODS OF FIRST YEAR (AFTER BREND)

YEAR	UNDER 1 MONTH OF AGE	2 TO 3 MONTHS OF AGE	TOTAL UNDER 3 MONTHS OF AGE	4 TO 6 MONTHS OF AGE	7 TO 12 MONTHS OF AGE
1905	41.8	24.8	66.6	24.8	36.8
1906	41.9	25.7	67.6	27.0	37.9
1907	40.7	23.3	64.0	21.3	32.3
1908	40.3	24.2	64.4	23.6	32.4
1909	39.7	20.4	60.1	19.2	29.4
1910	38.5	20.0	58.5	18.8	28.2
1911	40.6	24.8	65.4	26.1	38.5
1912	38.4	17.6	56.0	14.8	23.9
1913	39.4	20.3	56.6	19.8	28.8
1914	38.5	19.4	57.9	18.8	28.0

Deaths in the various months of the first year of life in the registration area of the United States are shown in Fig. 106.

As Brend observes in England and Wales, the death rate during the first month of life (arising from developmental conditions, prematurity, congenital debility, etc.), has remained almost stationary for nine years. During the second and third months, it has fallen about 20 per cent, during the fourth, fifth and sixth months about 24 per cent; and from the seventh to the twelfth month about 24 per cent: in each comparing the rate in 1905 with that in 1914. This is also true in the United States, as will be seen from Fig. 107.

The relative importance of the different groups of causes of death during the first year of life is shown in Table LXXVI.

TABLE LXXVI

CAUSES OF INFANT DEATHS—UNDER 1 YEAR, ENGLAND AND WALES
1914 (AFTER BREND.)

Deaths under 1 year per 1,000 living births.

Developmental Conditions Prematurity, congenital debility, etc.		35.97
Respiratory Diseases		19.13
Pneumonia	10.40	
Bronchitis	7.75	
Pulmonary tuberculosis	.35	
Other respiratory diseases	.63	
Diarrhea and Enteritis		17.37
Whooping Cough		4.38
Measles		2.14
Other Diseases		25.63

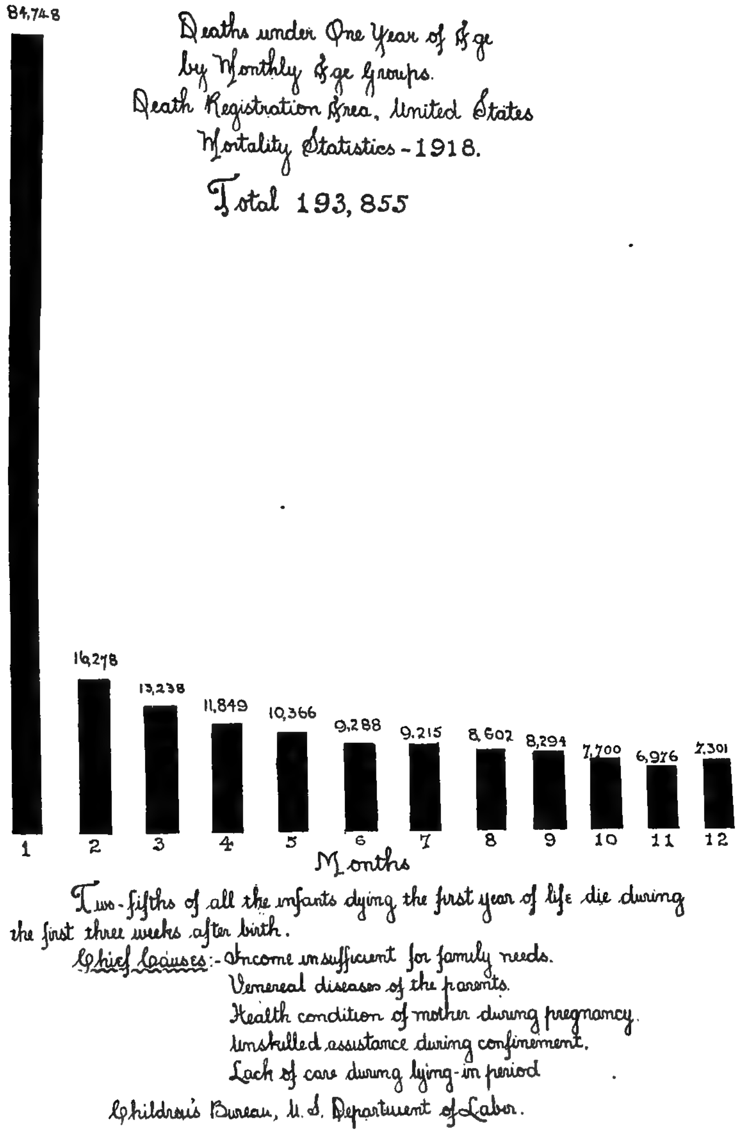
Deaths under One Year of Age
by Monthly Age Groups.
Death Registration Area, United States
Mortality Statistics - 1918.
Total 193,855
84,748
16,278
13,238
11,849
10,366
9,288
9,215
8,602
8,294
7,700
6,976
7,301
1
2
3
4
5
6
7
8
9
10
11
12
Months
Two-fifths of all the infants dying the first year of life die during the first three weeks after birth.
Chief Causes:- Income insufficient for family needs.
Venereal diseases of the parents.
Health condition of mother during pregnancy.
Unskilled assistance during confinement.
Lack of care during lying-in period
Children's Bureau, U. S. Department of Labor.

Fig. 106.

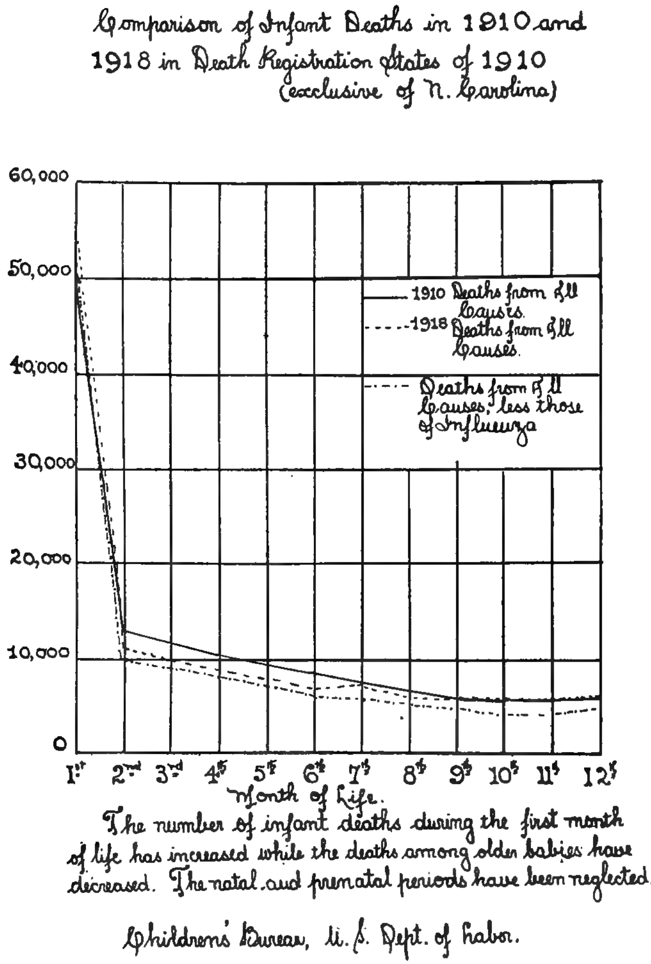

Fig. 107.

In the registration area of the United States the relative importance of the different causes is shown in Fig. 108.

The relation of season to infant mortality is well shown in Fig. 109.

In the Province of Ontario in 1919, the deaths of infants and children under five years of age were due to the following causes:

Fig. 108.

Total	7,849	
Developmental conditions or diseases of early infancy		2,828
Acute respiratory diseases		1,195
Diarrhea and enteritis (under 2)	996	
(over 2)	54	
Total	*1,050*	1,050
Acute communicable diseases		1,272
Diphtheria and croup	225	
Whooping cough	157	
Influenza	448	
All others (measles, scarlet fever, etc.)	442	1,404
(including 132 deaths from tuberculosis all forms)		

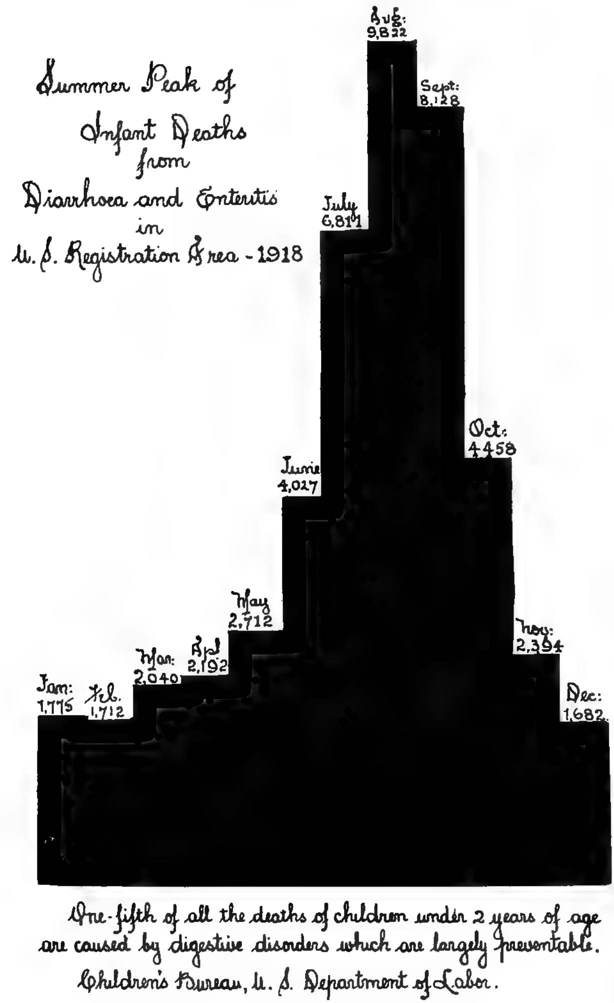

Fig. 109.

Above is shown that there were 7,849 deaths in Ontario in 1919, among children under five years of age, and that 5,999, over 75 per cent of these were in infants under one year. This indicates the relative importance of the age period, 0-1 and 1-5 years, in their relation to infant mortality.

The conclusions to be drawn from this review of the statistics of

infant mortality may be briefly summarized. There is, first, a group of causes of deaths among young infants, especially during the first three months of life the exact causes of which are not yet thoroughly understood. For purpose of tabulation they are recorded as deaths from prematurity, congenital debility, marasmus, etc. These are probably the result of antenatal conditions. But as Ballantyne has pointed out, during the first month of life, the neonatal period, antenatal and certain postnatal factors unite in their attack upon the newborn infant. As a result, between one-third and one-half of all the deaths which occur during the first year of life take place in the first four weeks of it. This mortality may be lessened by antenatal work among expectant mothers, but there is also needed careful, exact work to elucidate the precise causal factors operating at this time.

Then there follow the three groups of causes of death, respiratory infections, diarrhea and enteritis, and other acute communicable diseases. These are responsible for a large proportion of infant deaths and their incidence can be markedly reduced by active child hygiene work. There are a number of external environmental factors which have been held to be important predisposing causes of infant mortality. Certain investigations made by the Staff of the Children's Bureau of the Department of Labor of the United States, would seem to indicate that a baby's environment and economic condition to a great extent determine whether or not it will survive. Similarly, ignorance on the part of the mother has been held to be an important factor. Others have laid stress upon the harmful influence of industrial employment of expectant mothers, and finally, it has been stated that bottle-feeding bears a very important relation to infant mortality. In the article, "The Care of the Baby," which appeared as supplement No. 10 to the Public Health Reports, United States Public Health Service, December 19, 1913, the statement is made that "Out of every 100 bottle-fed babies an average of 30 die in the first year, while of the breast-fed babies only about 7 out of every 100 die in the first year."

In an interesting study of breast-feeding, Alan Brown has investigated in Toronto the percentage of children being breast-fed among Canadian-, American- and foreign-born mothers. The comparative percentages are shown in Table LXXVII.

To ascertain whether there was a difference in the percentage of

TABLE LXXVII

COMPARISON OF BREAST FEEDING RESULTS IN AMERICAN-BORN, FOREIGN-BORN AND CANADIAN-BORN

BREAST FEEDING	AMERICAN MOTHERS PERCENTAGE	FOREIGN MOTHERS PERCENTAGE	CANADIAN MOTHERS PERCENTAGE
One to three months	83	88.1	79.6
Three to six months	63	77	60.5
Six to nine months	63	70.3	31.8

mothers nursing their infants at the time this study was made (1917), and twenty years earlier, and, also to contrast mothers of the present time of different social and economic status (public ward and private patients) this author obtained the information shown in Table LXXVIII.

TABLE LXXVIII

NUMBER OF CASES		PER CENT ARTIFICIALLY FED FROM BIRTH*	PER CENT NURSING UP TO 3 MONTHS†	PER CENT NURSING UP TO 6 MONTHS‡	PER CENT NURSING UP TO 9 MONTHS§	PER CENT NURSING OVER 9 MONTHS
Students and nurses	137	12.4	87.6	84.7	76.6	29.9
Private patients	633	24.0	76.3	46.7	30.4	9.8
Clinic cases	946	16.53	79.65	60.51	31.88	....

*Approximately 10 per cent less artificial feeding twenty years ago.
†Approximately 10 per cent more nursing twenty years ago.
‡Approximately 30 per cent more nursing twenty years ago.
§Approximately 50 per cent more nursing twenty years ago.

Present day nursing figures in comparison with those of over twenty years ago. Of 250 cases weaned in private practice, 32 per cent were weaned on account of dyspeptic symptoms and the remainder did not have enough milk.

Brend in a very careful study of infant mortality in England and Wales, states that "the death rate among infants during the first month of life, differs but little, in different social classes and different types of environment, but as the child gets older the mortality rate in unfavorably situated classes becomes progressively higher." The general conclusions arrived at by Brend are of so much interest that they are worthy of quotation in full:

"It appears, then, that under the term 'infant mortality' we are classing together two radically different types of causes of death, which are brought about by different causes and are governed by different influences. The first type consists of deaths due to developmental factors which vary but little from place to place, year to year,

and class to class, and appear to be caused by fundamental influences which we do not fully understand, and at present seem unable to control. The second type consists of deaths mainly due to respiratory diseases and enteritis caused by influences in the postnatal environment, most prevalent in crowded, smoky, industrial and mining districts, and probably entirely preventable.

"These two types of deaths overlap somewhat, but the end of the first month gives us a fairly sharp line of division. Some 75 per cent of all deaths before that line are due to developmental conditions, though the proportion among miners, textile workers, and unskilled laborers is rather less. On the other side of the line, the proportion of deaths due to the developmental conditions is small. Some three-quarters of mortality in the first month represents a bedrock loss of life which we have hitherto failed to reduce, and may continue so to fail, indefinitely. Mortality after the first month is part and parcel of the general mortality of childhood, due apparently to the same causes, and demanding for its reduction the same measures. The use of the term 'infant mortality'—applying only to deaths in the first year—is apt to be misleading, since it tends to concentrate attention upon that year, and obscure the fact that the same influences are acting upon all young children after the first month and producing the same variations and tendencies. It might be an advantage to drop this term and speak of those in the first month as 'birth mortality,' and those from the end of the first month to say the end of the third year as the 'mortality of early childhood.' The great centers of deaths in infancy and early childhood are overcrowded industrial cities, and the measures which will benefit all classes of the community—clearing the slum areas, provision of open spaces, segregation of factories as at Letchworth, and the prevention of atmospheric pollution—are also those which will reduce infant mortality."

From the social and economic standpoint the conclusions arrived at by investigators of the Children's Bureau of the United States Department of Labor, are that "safety zones" for babies are essential. A safety zone is one in which:

(a) The majority of fathers earn living wages.

(b) Mothers are not employed during the year before or year after the baby's birth.

(c) Proper maternal care is provided during the period of childbirth.

(d) The father and mother are literate, i.e., able to read and write.

(e) Proper housing conditions exist.

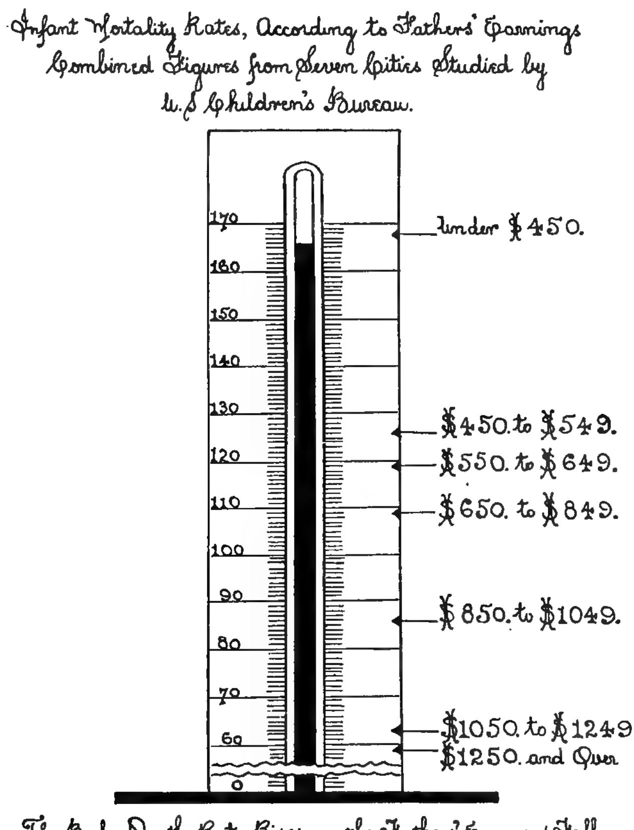

Fig. 110.

The economic relation is shown in Fig. 110.

In addition to the great loss in infant lives each year there is an immense volume of sickness and disability which is in large part preventable. The exact quantity and character of this is difficult, if not at present impossible, to determine. Very much light is

shed on the subject, however, by the results of the physical and mental examination of school children.

General Measures for the Reduction of Infant Mortality

In addition to proper antenatal supervision and arrangements for adequate medical and nursing service during confinement, other safeguards for infant lives are necessary.

1. Periodical medical examination of the baby by a physician well trained in pediatrics and methods of infant-feeding. This service every well-trained physician may be able to render. However, in large cities there are usually required in addition, baby-health centers or "well-baby" clinics, operated under the local health department or in cooperation therewith. One such center for every 20,000 inhabitants in large cities is desirable.

Mothers are encouraged to take their babies to a center, where they may be weighed, measured, and examined. The mother is given instructions in the proper methods of feeding and clothing her child, also the nature and importance of rest, and various points in general hygiene and those of sanitary importance, are indicated. Very often booklets outlining what the mother should know are distributed also. The mothers are invited to return at regular intervals, and, in the case of those babies, where it is very important that they should be brought back to the clinic, a public health nurse or social worker visits the home and endeavors to ensure this. Home visitation or follow-up, as well as regular visits to the "well-baby" clinic are essential for those mothers and babies for whom the centers are established. The public health nurse or social worker visiting the home can do much by actual demonstration to teach the mother what she should know in regard to the care and management of her baby. Registration of the baby's birth should always be the concern of the physician even though he has not attended the mother in confinement. Public health nurses, social workers and others similarly engaged in the field of child hygiene should regard it as an obligation, to do all that they can, to see that the birth of every child is registered.

Pure water and clean milk are essential in every community if the infant mortality rate is to be lowered. This has already been referred to in connection with the infant deaths due to diarrhea and enteritis. In this connection too great stress cannot be placed upon the importance of breast-feeding. Breast-fed babies, as has

already been indicated, have nearly four times the chance of survival in the first year of life that bottle-fed babies have. Therefore, a great duty rests on the physician to do all in his power to encourage breast-feeding where such is possible; otherwise suitably modified milk (preferably pasteurized) should be used. If the infant deaths due to ignorance and the employment of improper methods of feeding could be eliminated, the immediate saving in child lives in many communities would be very considerable indeed.

Infants and young children should, of course, be given only pure water. Boiled water is within the reach of every one and it is better to use it during the first year of life. By vaccination during this period also, the child will be protected against smallpox. Furthermore this desirable procedure will be carried out at a time when the child experiences the minimum amount of discomfort and reaction as the result of vaccination.

Protection from respiratory infections and other acute communicable diseases is especially important in infancy and early childhood. The significance of these as causes of death has already been indicated. Adults and older children suffering from common colds or other infections should take especial precautions to avoid transferring the infections to infants and younger children. The menace of careless coughing, sneezing, spitting, in conveying droplets of infectious material has been discussed elsewhere. Isolation of any child suffering from any acute communicable disease may be the means of saving a baby's life. Whooping cough, measles, and diphtheria infections, are often conveyed to the baby by older children of school-age. Efforts to guard against this are necessary. The danger of neglect of sore throats in infants and young children has been referred to at length under diphtheria. Deaths from measles, whooping cough, and diphtheria are vastly more prevalent in infants and children under five years of age than at any other time of life.

Since it is evident that education of mothers is a most important factor in this work, the community should make provision and see to it that every mother has received the necessary information. The great value of work of this character is seen in the results achieved in New Zealand where as the result of governmental activity, aided greatly by voluntary effort, the infant death rate is lower than that of any other country in the world. The employment there of public

health nurses for educational work and demonstrations (the so-called Plunket Nurses) has been found to be of great value. The work both of antenatal and "well-baby" clinics or centers is not entirely satisfactory unless supplemented by home visitation and for this purpose, public health nurses are essential. Home visitation will reach many cases that will not attend at the centers.

The following diagram prepared by the New York State Department of Health shows the various fields of usefulness which may be filled by public health nurses. Every community should employ one or more according to its needs. Winslow has proposed one public health nurse for every 2,000 persons in any community.

The number of infants and young children receiving supervision in "well-baby" clinics in many cities includes a very considerable percentage of all children under two years of age. In the City of Toronto during 1920, there were conducted by the Department of Public Health in conjunction with the Hospital for Sick Children 23 Child Hygiene or "Well-Baby" Clinics, including a Nutrition Clinic.

The estimated population of this City in 1920 was about 508,000, the estimated number of children under two years of age about 25,000. During the year, 5,136 children of whom 92 per cent were under two years of age were supervised in these clinics. The age at which the children were first brought to the clinic is shown below:

First month of life	18 per cent
Second month of life	43 " "
Under 6 months of age	71 " "
Under 9 months of age	80 " "
Under 1 year of age	86 " "
Between 1 and 2 years of age	6 " "
Over 2 years of age	8 " "

An interesting fact recorded was that relating to the percentage of these children under nine months of age that were being breast-fed. This was found to be:

57 per cent breast-fed—only
8 per cent combination of breast and artificial feeding.
35 per cent artificially fed.

The health problems of the pre-school and school-age child are also exceedingly important. The pre-school age is usually understood to mean the years from two to six in the child's life.

HAS YOUR COMMUNITY A PUBLIC HEALTH NURSE?

Public Health Nurses are employed by:

State and City Health Departments,
Town and Village Boards of Health,
School Boards,
Poor Officers,
Tuberculosis Societies,
Charitable Organizations,
Children's Aid Societies,
Church Organizations,
Factories, Large Stores, etc.

THE PUBLIC HEALTH NURSE AND THE WORK SHE DOES

EDUCATES THE PUBLIC IN THE CARE AND PREVENTION OF SICKNESS
by
Visiting Homes of the Sick.
Instruction in Nursing the Sick.
Distributing Literature.
Delivering Lectures.
Teaching First Aid.

SAVES LIVES OF NEWBORN BABIES
by
Visiting and Instructing Mothers.
Assisting Mothers in Carrying Out Physician's Orders.
Working in Milk Stations and Child Welfare Stations.
Giving Lectures to Mothers and Children.
Teaching "Little Mothers' League".
Supervision and Instruction of Midwives.

PREVENTS AND RELIEVES TUBERCULOSIS
by
Instruction in Preventive Measures.
Helping to Secure Admission to Hospital or Sanitorium.
Helping to Secure Aid when Needed.
Helping to Secure Suitable Employment after Recovery.

SAVES LIVES OF INDUSTRIAL WOMEN
by
Giving First Aid in Industrial Plants when Accidents or Sudden Sickness Occur.
Teaching First Aid.
Assisting Surgeons in Emergency Dispensaries.
Improving Sanitary Conditions.
Giving Lectures to Employees.

HELPS TO PREVENT POVERTY
by
Directing the Poor to Agencies for Relief.
Cooperating with Relief Societies, Churches, etc.
Cooperating with Employers.
Helping Convalescent Patients to Secure Employment.

PREVENTS COMMUNICABLE DISEASES AMONG CHILDREN
by
Assisting School Physicians in Making Inspections.
Home Visits to Advise Parents and Assist in Carrying Out Inspectors' Orders.
Assisting Teachers to Discover Contagious Diseases.

DOES FIELD WORK FOR DISPENSARIES AND HOSPITALS
by
Home Visits to Outdoor Patients to Instruct Them.
Assists Physicians in Dispensaries.
Aids the Convalescent Patient at Home.
Giving After-Care in the Home.
Carrying out Physicians' Orders in Homes of the Sick.

EMERGENCY WORK
by
Nursing the Sick in Times of Serious Epidemics.
After-Care to Convalescents Following Epidemics.
Nursing and Relief Service in Times of Fire, Flood, or Other Public Catastrophe.

NEW YORK STATE
DEPARTMENT OF HEALTH
ALBANY

According to Dr. Josephine Baker of the Division of Child Hygiene of the Health Department of the City of New York, it has been established that in the United States 81 per cent of the deaths from all communicable diseases and 85 per cent of the illness from such diseases occur in children under five years of age.

Physical examinations of children of this age-group, according to the same authority, have revealed a prevalence of physical defects, from 10 to 15 per cent in excess of those found in children of school age. Undernourishment also is believed to be one-third more prevalent in pre-school age children, than in those from six to fifteen years of age. In the case of children who are brought to a "well-baby" clinic during the first two years of life their supervision during this pre-school age period is often a matter of difficulty. Where the mothers of the children understand the significance of proper food, clothing, exercise, sleep and rest, fresh air, etc., in their relation to the health of growing children all may be well, but it would seem from the results of examinations of school children that many a child of pre-school age has not had proper health supervision.

The problem after existing defects have been corrected is really one of inculcating notions of personal hygiene and the acquirement by the children themselves, of sound health habits. The further extension of public health nursing work is likely to assist materially in the solution of the problem as to how to teach children of this age period. Children whose parents are in a position to afford the services of the family physician for this work of health supervision, should have periodic examinations until they enter school.

A question that is of more than ordinary interest to the average parent is that relating to heights and weights. Table LXXIX bearing on the subject is taken from the publication "Child Care," Care of Children Series No. 3, Bureau Publication No. 30, U. S. Department of Labor, Children's Bureau.

For children of pre-school age who do not come under the supervision of a private practitioner, children's health conferences or child hygiene clinics are desirable, and for the care of some children properly supervised *day nurseries* may be maintained. Where day nurseries are established, they should be under the supervision of the local health department. No nursery should be permitted to open or operate without the consent of the health department.

Where adequate and proper supervision is maintained results are obtained which are distinctly valuable. Dr. Josephine Baker has stated that "in New York City the enforcement of such an order (regulating the conduct of day nurseries) has resulted in standardizing the conduct of day nurseries in that city, and they are at present (1919) an active and potent force in the public health program for child welfare."

There is general agreement that in so far as child health is concerned where it is possible for mothers to remain at home and personally care for their children, the best results follow if the mother's care is that of one instructed in the elements of child hygiene. If this is supplemented by children's health conferences and the necessary follow-up by public health nurses, especially trained in child hygiene, excellent results are almost certain to be obtained.

Children's health conferences have as their chief purpose the education of mothers. They may be conducted anywhere by physicians trained in child hygiene. The conference is one of the examining physicians, child hygiene nurses, with mothers and their children. The children are given a careful physical examination, are weighed and measured, and any defects found brought to the attention of the mothers. It is essentially for the discovery of defects in children of pre-school age, in order that suitable remedial measures may be instituted. Ordinarily, no medical advice is given. If such is necessary the mother is referred to her physician or to a suitable hospital clinic. The conference physician enters on a special record sheet the result of his examination and a summary of the advice given to the mother, and a copy of this record sheet is given to her.

Children's health conferences are conducted by state, provincial and local health departments, and sometimes by voluntary health-promoting agencies. It is essentially a practical demonstration to any community of the value of maintaining the health of children by periodic medical examination, by correction of defects and by teaching and practice of sound rules of healthy living.

Where medical inspection of school children has already been started in a community, such a children's health conference emphasizes for the benefit of every one, the importance of preventive measures among children of pre-school age also. There is no better method perhaps, of stimulating general public interest in infant

TABLE LXXIX

TABLE OF HEIGHTS AND WEIGHTS OF CHILDREN[a]

AGE	BOYS HEIGHT INCHES	BOYS WEIGHT POUNDS[b]	GIRLS HEIGHT INCHES	GIRLS WEIGHT POUNDS[b]	AGE	BOYS HEIGHT INCHES	BOYS WEIGHT POUNDS[b]	GIRLS HEIGHT INCHES	GIRLS WEIGHT POUNDS[b]
Birth	20.6	7.6	20.5	7.16	33 mths	36 1/8	30 5/8	35 5/8	29 1/8
3 mths	23 1/2	13			34 "	36 1/2	31 1/8	36 1/2	30 1/8
6 "	26 1/2	c18	25 7/8	c16 3/4	35 "	36 3/4	31 7/8	36 1/2	30 1/4
7 "	27 1/4	c19 1/8	26 1/2	c17 3/8	36 "	37 1/8	32 1/4	36 3/4	30 1/2
8 "	27 5/8	c19 3/4	27	c18 1/4	37 "	37 3/8	32 1/4	36 3/4	30 3/4
9 "	28 1/8	c20 3/8	27 5/8	c19 1/8	38 "	37 1/2	32 3/8	37	31
10 "	28 1/2	c20 7/8	27 7/8	c19 1/2	39 "	37 7/8	33 1/8	37 1/4	31 5/8
11 "	29	c21 3/8	28 3/8	c20 1/8	40 "	38 1/2	33 1/2	37 1/2	32
12 "	29 3/8	c21 7/8	28 7/8	c20 3/4	41 "	38 5/8	33 5/8	37 3/4	32 1/4
13 "	29 7/8	c22 7/8	29 3/8	c21	42 "	38 5/8	33 3/4	38	32 1/2
14 "	30 1/4	c23	29 1/2	c21 5/8	43 "	38 3/4	33 3/4	38 1/4	32 3/4
15 "	30 3/4	c23 5/8	30 1/8	c21 7/8	44 "	38 7/8	34 1/4	38 1/2	33
16 "	31 1/8	c24 1/8	30 1/2	c22 5/8	45 "	39	34 1/2	38 1/2	33 1/4
17 "	31 3/8	24 1/2	30 3/4	c22 7/8	46 "	39	34 3/4	38 3/4	33 1/2
18 "	31 3/4	c24 5/8	31 1/8	c23 3/8	47 "	39 1/4	35 3/4	38 7/8	33 1/2
19 "	32 1/4	c25 1/2	31 1/2	c23 3/4	48 "	39 1/2	35 7/8	39	33 3/4
20 "	32 5/8	c25 3/4	32	c24 1/8	5 yrs.	41.6	41.1	41.3	39.7
21 "	32 7/8	c25 3/4	32 1/4	c24 3/4	6 "	43.8	45.2	43.4	43.3
22 "	33 1/4	c26 7/8	32 5/8	c25 1/4	7 "	45.7	49.1	45.5	47.5
23 "	33 5/8	c27	32 7/8	c25 5/8	8 "	47.8	53.9	47.6	52.0
24 "	33 3/4	c27 1/8	33 3/8	c26 3/8	9 "	49.7	59.2	49.4	57.1
25 "	34	27 7/8	33 3/4	26 7/8	10 "	51.7	65.3	51.3	62.4

TABLE LXXIX—CONTINUED.

TABLE OF HEIGHTS AND WEIGHTS OF CHILDREN[a]

AGE	BOYS HEIGHT INCHES	BOYS WEIGHT POUNDS[b]	GIRLS HEIGHT INCHES	GIRLS WEIGHT POUNDS[b]	AGE	BOYS HEIGHT INCHES	BOYS WEIGHT POUNDS[b]	GIRLS HEIGHT INCHES	GIRLS WEIGHT POUNDS[b]
26 mths.	34 1/8	28 1/4	33 7/8	27 1/4	11 yrs.	53.3	70.2	53.4	68.8
27 "	34 3/4	29	33 7/8	27 1/4	12 "	55.1	76.9	55.9	78.3
28 "	35 1/8	29 1/8	34 5/8	27 3/4	13 "	57.2	84.8	58.2	88.7
29 "	35 3/8	29 1/4	34 3/4	27 3/4	14 "	59.9	94.9	59.9	98.4
30 "	35 3/8	29 1/2	34 7/8	28 1/4	15 "	62.3	107.1	61.1	106.1
31 "	35 1/2	30 1/2	35 1/8	28 3/4	16 "	65.0	121.0	61.6	112.0
32 "	36	30 5/8	35 3/8	29					

[a]The figures for height and weight at birth are from L. Emmett Holt (Diseases of Infancy and Childhood, 1916, p. 20), and are based on original observations. Those of boys at three months were given in a personal communication by Dr. Holt. The figures for height and weight from 6 to 48 months are from the Anthropometric Table compiled for the American Medical Association by F. S. Crum, and are based on the measurements of 10,423 normal babies (5,602 boys and 4,821 girls) examined at Baby Health Conferences in 31 states, and possibly represent measurements slightly above the average, especially in weight. The figures for height and weight from 5 to 16 years are quoted from Bowditch (Eighth Annual Report of the State Board of Health of Massachusetts, 1877, p. 275) and are based on the measurements of 23,931 Boston school children of American and foreign parentage (13,415 boys and 10,516 girls). They agree very closely with the table of average American height calculated by Boas from the data of 45,151 boys and 43,298 girls in the cities of Boston, St. Louis, Milwaukee, Worcester, Toronto and Oakland; and the table of average American weight calculated from the data of about 68,000 children in the cities of Boston, St. Louis and Milwaukee. (See Baldwin, B. T., Physical Growth and School Progress, U. S. Bureau of Education Bulletin, 1914, No. 10. Whole No. 581, p. 150.)

[b]Approximate equivalents of decimal fractions of a pound in ounces: 0.1, 1½; 0.2, 3; 0.3, 4½; 0.4, 6; 0.5, 8; 0.6, 9½; 0.7, 11; 0.8, 12½; 0.9, 14; 1.0, 16.

[c]The weights given in this table for children under 2 years are somewhat higher than those given by L. Emmett Holt, (Diseases of Infancy and Childhood, 1916, p. 20). These are—6 months: Boys 16 pounds, girls 15.5 pounds; 12 months: Boys, 21 pounds, girls 20.5 pounds; 18 months: Boys 24 pounds, girls 23.5 pounds; 24 months: Boys 27 pounds, girls 26 pounds. A variation of from 1 to 2 pounds from the averages given in the table above should therefore not be considered abnormal. The heights given in the above table correspond very closely to those given by Holt.

and child hygiene work. Subsequent public health nursing and child health organization, is very likely to follow the holding of these conferences.

The conferences differ from clinics in that as a rule gratuitous medical advice is not given. Defects are detected, their correction advised; and at the same time valuable educational work is possible, through interviews with the mothers.

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CHAPTER XIX

SCHOOL HYGIENE, HEALTH SUPERVISION OF CHILDREN OF SCHOOL AGE, INCLUDING SCHOOL MEDICAL, DENTAL AND NURSING SERVICE

Health supervision of children of school age is now generally admitted to be an essential duty of the state. In addition, however, a very definite responsibility devolves upon the parents, and the effectiveness of efforts put forth by the community will to a considerable extent be influenced favorably by their support and cooperation; or adversely by their indifference or open hostility.

Since the supervision of health of children between the ages of six and fourteen is so largely conducted in the schools, many persons assume that the work is all done there, and that the influence of parents and home conditions is not of great significance. Quite the contrary is actually the case. Entirely effective health supervision of children of school age will be provided only with the most complete and cordial cooperation of parents and children, of teachers and those more directly concerned, namely, physicians, dentists and school nurses.

It has already been intimated that health supervision of infants and children of pre-school age is highly desirable. It is recognized, however, that the actual extent of such health work is very slight. Machinery for its conduct among the majority of children has not yet been created.

In the case of a few children of pre-school age whose parents desire it and are financially able to pay for it, health supervision is now provided.

However, it is realized that in all probability among 95 per cent of children no examinations or health supervision will be undertaken unless the community makes the necessary provision for the work. It is also admitted that since education is compulsory (usually between the ages of six or seven and fourteen) and because certain health hazards are accentuated, in school, that the com-

munity owes it to the child, to afford all possible protection against such additional risks.

Then, too, it is appreciated that if physical examinations of children reveal the presence of physical defects of a remediable character, which if neglected are likely to retard the child's physical or mental development it is highly desirable to have all such defects terminated at the earliest possible moment. Such physical defects are now well known to be the heritage of a large percentage of school children.

School medical service has been carried on in various communities for more than twenty-five years. England and Wales in 1907 by provision of financial assistance encouraged its general introduction, and this was the first adoption of the system, on a nation-wide scale. The results there have made it evident that such work is most essential. The service includes medical, dental and nursing care. While general physical defects are very numerous, it has been determined that dental defects are almost universal, among school children, and it is believed that these defects are responsible for a considerable volume of preventable sickness and disability. In an interesting article entitled "Children's Teeth, a Community Responsibility" Clark and Butler conclude "Mouth hygiene is a business proposition. Regardless of one's means of getting a living, we are all in the business of educating our children. To manage this business we employ a superintendent, but in no other business, as is so often the case in this, would we allow our interests to cease with his employment.

"The per capita cost of educating a child is obtained by dividing the total school budget by the number of children in attendance. If a child fails to make a grade, the situation is exactly the same as though a manufacturer found that after passing through the plant an article was defective and unsalable. Furthermore, if it was found that a large proportion of the products of the plant were unmarketable, would not immediate steps be taken to remedy this condition? The establishment of school dental clinics and the teaching of mouth hygiene is one of the important remedial steps which should be taken in the school plants. A reduction in the percentage of retarded children not only means fewer school buildings and reduced overhead charge, but also makes possible the employment

of better teachers. As a matter of dollars and cents, mouth hygiene offers splendid returns for each dollar expended in the better growth and development of the children and by assuring better physical types."

The extent of physical debility among children of school age will be understood by a consideration of the estimate of Wood who has expressed the opinion that "At least one per cent or 200,000 of the 22,000,000 school children in the United States are mentally defective. Over one per cent, or 250,000 at least, are handicapped by organic heart disease. At least 5 per cent, or 1,000,000, now have, or have had, tuberculosis, a danger often to others as well as themselves.

"Five per cent or 1,000,000 have defective hearing, which unrecognized gives many the undesired reputation of being mentally defective. Twenty-five per cent, or 5,000,000, have defective eyes. All but a small percentage of these can be corrected and yet the majority of them have received no attention. From 15 to 25 per cent, 3,000,000 to 5,000,000 have adenoids, diseased tonsils or glandular defects. From 10 to 20 per cent or from 2,000,000 to 4,000,000 have weak foot-arches, weak spines or other joint defects.

"Twenty-five per cent at least, or 4,500,000 are suffering from malnutrition. Every child who is 10 per cent or more below weight for his height and age is suffering from malnutrition, and persistent efforts by cooperation of school, home, and community should be made to correct this. Poverty is not the most important cause of this serious barrier to health development.

"From 50 to 75 per cent, or from 11,000,000 to 16,000,000, of our school children (and in many communities as high as 98 per cent) have defective teeth, and all defective teeth are more or less injurious to health. Some of these defective teeth are deadly menaces to their owners. This is the greatest problem, from the standpoint of its seriousness and from the standpoint of its enforcement that we have."

In the public and separate schools in the City of Toronto during 1920, 20,000 complete physical examinations of children between the ages of six and fourteen were made. The results were as follows:

Total examined	20,000
Number found to have defects*	9,400
Total defects among these 9,400	12,901
Number with diseased tonsils	4,000
Number with obstruction of nasal passages (including those with adenoids)	2,500
Number found to have defective eyesight due to errors of refraction	1,200
Malnourished	1,400

Among 9,400 children presenting physical defects 680 were found to have some serious physical disability.

326	Cardiac
161	Nervous
82	Digestive
111	Pulmonary

Probably 90 per cent of the defects found in these children were remediable and required the immediate application of appropriate treatment.

In the yearly dental survey during 1920 among a total of 67,000 children examined for dental defects, 42,000, or about 66 per cent, were found to be suffering from such defects.

These figures are relatively low because this service has now been in operation for a number of years. From a consideration of these results the necessity for conducting routine physical examinations of all school children is obvious. This, however, should in all instances be followed up by an effort to impress upon the parents the importance of having such defects corrected at the earliest possible moment.

School health supervision is not only valuable in that remediable physical defects are brought to light and correction thus made possible, but it also facilitates the early detection of cases of communicable diseases, and by their prompt exclusion is a means of preventing epidemics of these. And, perhaps most important of all, it provides a means of giving the all essential training in elementary personal hygiene, the opportunity to teach and develop in the children sound health habits. This health work in the school therefore serves three main purposes:

*(By defect is meant a physical condition requiring early attention.)

(Malnourished means 10 per cent or more underweight for height and evidence of other symptoms of malnutrition. In addition it was found in a survey conducted by Alan Brown and Davis that 26 per cent of the children examined were 10 to 12 per cent underweight for height.)

(1) The early detection of cases of communicable diseases and their exclusion—(of great value in the prevention of epidemics) is made possible.

(2) Through complete examinations of children, defects are detected, parents are informed of the physical (and if necessary, mental) condition of their children and a recommendation is made to them to have such defects corrected.

(3) Providing an opportunity of developing in children a knowledge of, and interest in, the essentials of healthy living.

In addition to the work of physical examination of school children, equally essential and complementary activities are the mental examinations by intelligence tests, etc., to ascertain which children present evidences of mental retardation.

This work is now undertaken as a rule by trained psychiatrists, assisted by nurses who have had special training in public health, psychiatry and mental hygiene. The interest now being taken everywhere in questions of mental health is an index of the great importance of the subject. It is very essential from every point of view that children showing definite mental retardation should be separated from other children and be taught in special classes.

Dr. Eric Clark, psychiatrist of the Health Department of Toronto, in a very interesting survey made in the Toronto public schools, during the years 1919-1921, when 57,792 children were examined, found that 1,247 children were mentally defective, (that is they had an intelligence quotient of 75 per cent and under) and 85 additional children were psychopathic. This total represents 2.15 per cent of the children surveyed. Practically all of the cases investigated were reported by the teachers as being over-age for grade, dull in class work, and a number were chronic truants and some incorrigible. The proper disposition of these cases is to establish special auxiliary and industrial classes to which they may be assigned.

The removal of these mentally subnormal children has a most beneficial effect upon the children in the classes from which they are removed, and the mentally retarded children receive the benefit of special teaching and are much improved thereby. To carry out a suitable mental hygiene program in schools it is necessary that teachers be familiar with the important facts of normal and abnormal psychology. This is essential for two reasons. First that children may receive during their school life sound training in normal

mental habits and secondly that the teachers may assist in picking out the mentally retarded children. By this means accurate statistics of the volume of mental abnormality and subnormality among children can be determined.

Teachers and supervisors of special auxiliary or industrial classes must, of course, have unusual aptitude for this work, and they should have in addition the necessary training in psychiatry, psychology, and sociology. Mental examinations in addition to intelligence tests are desirable in the case of children showing psychopathic traits. Special institutions for feeble-minded are necessary and certain children should be sent to such an institution. The question of mental hygiene centers is dealt with in detail in the appendix.

A fundamental health problem in children both of pre-school and school age is that relating to nutrition. A condition of undernourishment or underweight is very common in children and it is one that at present is not at all well understood. The question of proper methods of feeding children is very often a closed book to the parents. In consequence of this, a very considerable volume of malnourishment prevails. The question of appropriate diets, and what constitutes a balanced diet are dealt with elsewhere. But malnourishment or malnutrition is not only a question of an inadequate or improper diet, it is also a matter of other improper health habits, such as insufficient rest and sleep, unsatisfactory environmental conditions, etc. A child may have home surroundings and conditions such that malnutrition will be almost inevitable, regardless of the economical status of the parents. Ignorance is not the cause, but it often explains why many cases of malnutrition arise.

The criteria as to what constitutes malnutrition are as yet only tentative. In a general way, children are said to be malnourished who are below normal weight and height; and who gain in weight more slowly than they should. Some authorities believe that all children 7 per cent underweight for height are malnourished, others only regard those children who are 10 per cent or more underweight for height, as suffering from malnutrition.

Many height and weight tables have been prepared showing normal weights and heights for boys and girls of various ages usually from five to eighteen years. The average monthly gain for children of various age periods is similarly indicated in these tables. There

is at the present time a tendency, sometimes on the basis of underweight only, to put many children in the malnourished group who perhaps should not be so categorized. The tables are used occasionally in an arbitrary way and due allowance is not made for various important determining factors.

In a recent number (March, 1921) of the Statistical Bulletin of the Metropolitan Life Insurance Company this question is considered in some detail and the importance of certain reservations emphasized. This summary is as follows:

"Nutrition work for children has been very extensively developed in recent years, but it has not yet been subjected to critical tests. In most places, this work has been based upon certain standards of height and weight, which, it has been assumed, indicate the healthy child. Children who are underweight for their age according to these standards have been usually assumed to be malnourished, and care has been directed to bring such children up to the standard. The tables most extensively used in this connection have been those recommended by the Child Health Organization of America.

"In the use of these tables, most nutrition workers have forgotten the limitations of which the authors themselves were well aware. For example, these standards reflect conditions primarily among native born children of native parents. They were never intended to test the degree of underdevelopment of children of foreign stocks, especially Italian and Jewish children, among whom so much nutrition work is done. Children of these race stocks are uniformly shorter and lighter than are children of native parentage. There is, in fact, much variability in the heights and weights of children of the various races, and such standards as are used should take the racial factor into consideration. Nutrition workers should develop adequate measures for the height and weight of healthy children in the particular race groups among whom they work. This will avoid much confusion and will result in considerable economy of effort; because many children who are now classed as malnourished, on truer standards, will be found well within the limits for healthy children of their race.

"In addition to the racial factor, there is another and perhaps more important element which has been very much overlooked in nutrition work, namely, the allowable normal departure from the average height and weight for age, irrespective of race. Healthy children of

whatever nationality vary considerably from the average in height and weight. Thus, the weights of healthy children of seven may range from 36 pounds to 62 pounds, and those of boys of fourteen all the way from 78 to 171. Even if we limit those boys who are 60 inches tall, we will find variations from 80 to 125 pounds, with the average weight at 97.7 pounds. There is, in other words, a "safety zone" on either side of the average which includes well nourished children. *The important requirement in this work is not so much to know the average weight for children of the various races, but the limits of variation which will include healthy children.* It has been assumed that any weight more than 7 per cent below the average establishes malnutrition and that the excess of 20 per cent above the average is an indication of obesity. It is quite clear that 7 per cent is not a safe lower limit until this has been established by the actual weights of children who are clearly determined to be malnourished on evidence other than weight.

"It should be remembered that underweight up to a certain point is in itself not a defect. Among adults, underweight is indeed a distinct advantage at certain ages. Thus, if longevity is a good test of fitness, underweight even up to 50 pounds below the average is an advantage among persons of forty-five years of age and over. The lowest mortality at certain age-divisions is not among those of average weight but among the so-called underweights.

"It is, therefore, important to emphasize the need for more exact standards in carrying on nutrition work, especially in our large cities where so much work is done among children of foreign extraction. And, in such work, more discretion should be used to exclude children who, although somewhat below table weight, are, nevertheless, healthy; that is free from other symptoms of malnourishment. *Underweight itself is not a final criterion of malnutrition.*"

There are doubtless a large number of children of school age in all communities who are suffering from malnutrition. However, in every case, in addition to merely determining height and weight, a careful complete physical examination is necessary and consideration of the child's mental make-up, and the knowledge of home conditions is essential. As Emerson has pointed out, there must be available in every case of malnutrition a history of the physical and mental status and a knowledge of environmental conditions in the home, etc.

Undoubtedly improper diet, coupled with an inadequate amount of rest and sleep contributes in many children, to an unfavorable condition of nutrition, which can be readily corrected, provided all the facts are known, and appropriate methods of treatment adopted. The methods used by Emerson in his nutrition classes have apparently been very successful among children whose parents cooperate. Proper diet lists are given to the parents and the interest and enthusiasm of the children is aroused by suitable educational methods. Small classes of about 20 children with their parents meet once a week with the physician and nurse conducting the class. The causes of malnutrition are explained, the activities of each child ascertained and sample lists of food taken in a 48 hour period are critically studied. In addition the amount of rest and sleep each child is taking, is learned. On the basis of this information the children are instructed as to what to eat; and a healthy daily routine is outlined, not omitting reference to the amount of sleep necessary. Other natural measures likely to promote health are advocated and are usually quickly adopted by the children who have become interested in their condition. These classes are continued for a number of weeks; and at regular intervals, perhaps once a week, the progress each child is making is reviewed and prizes are awarded, or some commendation given to the children making most satisfactory progress. The spirit of competition and emulation is aroused and thoroughly satisfactory team-work results.

Such nutrition classes are often conducted either in connection with child health centers or clinics and they should be a part of the local municipal public health work in those places where the need for them is at all evident. The volume of sickness largely of a preventable character is dealt with in the article by Dr. Phair in the appendix. The economic as well as the public health aspect of the question is there considered in its relation to organization and conduct of a school medical service.

Every physician in his own practice can give the necessary advice to parents in regard to proper means to employ to prevent children from becoming malnourished. Any child who is much underweight or is not making proper gains in weight, should be most carefully and thoroughly examined. Otherwise certain conditions may be overlooked. Cases of tuberculosis have been diagnosed as malnutrition because of failure to do more than simply take the child's height and

TABLE LXXX

PROPER FOOD FOR CHILDREN OF SCHOOL AGE

BREAKFAST	AMOUNT	PREPARATION	CHEAPER	MORE EXPENSIVE	MOST EXPENSIVE
(1) Cereal	2 to 6 tablespoonfuls	Cook 3 hours night before, in double boiler or fireless cooker	Bulk Cereals, Oatmeal, Cornmeal, Hominy, Rice, Farina.	Cereals in packages, Wheatena, Malt Breakfast Food, Cream of Wheat, Pettijohn's	Dry Cereals, Shredded Wheat, Force, Corn Flakes, Puffed Rice.
(2) Milk or Cocoa	1 cup 1 cup	1 teaspoonful to a cup (half milk, half water)	Milk gives the most food for the money even when very high priced		
(3) Bread and Butter	1 or 2 slices	(Stale or toasted)	Whole Wheat, Graham or Corn Bread	White Bread	Rolls or buns should not be used.
(4) Egg		Soft boiled or poached or scrambled with milk.			
(5) Fruit		Cook 2 or 3 hours without sugar. Soak over night if very dry.	Cooked apples, Stewed Prunes, Stewed Dried Peaches, Stewed Dried Apples.	Orange or Grapefruit	
DINNER:					
(1) Meat	A small piece about 2 ozs.	Stew, boil, roast or broil, *Do not Fry.*	Lamb stew, beef stew, cod, flounder, haddock, fresh halibut or fresh water fish.	Chopped Beef Chicken	Roast Beef, Beefsteak, Roast Lamb, Lamb chops.
or					
Vegetable Soup	1 bowl		Made from Peas, Split Peas, Beans, Lentils or any fresh vegetables		Broth or Meat Soup with Rice or Barley (little nourishment)
(2) Fresh Vegetables and Starchy Vegetables	2 or 3 tablespoonfuls 2 tablespoonfuls	Put into small amount of boiling water, cook until tender, drain off all water Boiled, baked, mashed, Do not Fry.	Spinach, Chard, Beet-tops, Greens, Carrots, Beets, Boiled Onion, Lima Beans (cooked 3 hours), Parsnips, Potatoes, sweet potatoes, hominy, spaghetti, macaroni.	Peas, String beans, Squash, Stewed Celery, Knob Celery	Cauliflower Oyster Plant
(3) Bread and Butter	1 or 2 slices	(stale or toasted)	Whole Wheat, Graham or Corn Bread	White Bread.	
(4) Dessert	1 or 2 tablespoonfuls.		Rice, Tapioca or Bread pudding cooked fruit (from list above.)	Junket, Custard, Cornstarch pudding	Gelatin, Ice Cream

TABLE LXXX—CONTINUED

PROPER FOOD FOR CHILDREN OF SCHOOL AGE

SUPPER	AMOUNT	PREPARATION	CHEAPER	MORE EXPENSIVE	MOST EXPENSIVE
(1) Soup	1 bowl		Vegetable soup—made from Split Peas, Beans, Lentils (from list above)		Meat Soups, if given, should be thickened with rice or barley.
or Cereal	1 or 2 tablespoonfuls		(from list above)		
or Egg		(soft boiled or poached or scrambled with milk)			
(2) Milk	1 or 2 cups				
(3) Bread and Butter	1 or 2 slices	(stale or toasted)	Whole Wheat, Graham or Corn	White Bread	
(4) Cooked Fruit	2 or 3 tablespoonfuls		Apple Sauce, Baked or stewed Apples, Stewed Prunes, Stewed Dried Peaches.	Stewed Dried Apricots, Baked Bananas	Fresh Fruit, Peaches, Pears, Oranges.

weight. Health rules for children of school age with suggestions as to diet may follow the lines of those given below, which are taken from the pamphlet issued by the Department of Public Health, of Toronto:

FOOD

Rules for Eating: Give no food between meals.

Make every child *eat slowly* and *chew* his food *well*—not wash it down with water or milk.

Urge children to drink water between meals, but not at bedtime.

Make every child wash his face and hands before meals.

Serve food warm and well cooked on clean dishes and at a clean table.

Keep flies away from food. Flies spread summer complaint.

Give at least one pint of milk each day to each child.

Keep milk cold (keep on ice if possible.)

Where possible, dinner for children should be at midday.

SLEEP

Children should get all the sleep they will take—they should not have to be wakened in the morning. It is during sleep that nature makes up the waste of the previous day and piles up reserve for the next day, in other words, growth occurs not only in stature but in vitality.

Maximum sleep means maximum health: Younger children should be asleep at 7 or 7:30 P. M., older children not later than 8.30 P. M. The child of 6 needs 12 to 13 hours of sleep when well and more if he is run down. The child of 14 needs 10 to 11 hours of sleep.

FRESH AIR

Fresh air is necessary for health. When going to school the child can get only about two to three hours of outdoor life, but he can get 10 to 12 hours of fresh air while asleep.

Keep the bed-room window always open during sleeping hours.

A very high percentage of children over ten years of age have been found to give positive reactions to intracutaneous tuberculin tests. Many of those between the ages of six and ten will also give the same reaction. In other words, tuberculous infection has already occurred in the children and a certain proportion will later manifest frank symptoms of the disease if intensely exposed to infection. The number of cases of active tuberculosis in school children will be small if vigorous measures are taken in any community to protect the children "contacts" of open adult cases of the disease. Where it is possible open-air classes should be conducted for tuberculin-positive children who are underweight. Certain children may require complete rest and the regimen which in a good home can be readily carried out; failing this, however, "Preventorium" treatment is advisable.

The early correction of defects is essential, as has already been emphasized. In addition diseased tonsils and adenoids should receive attention at once. Children showing serious cardiac defects may be suitably treated in special cardiac classes, which are now conducted in connection with child hygiene clinics. Physicians should be familiar with the methods employed in such classes. Special provision, too, is required for children presenting serious postural defects or conditions requiring orthopedic treatment. Special classes for children with visual defects are conducted in certain schools. In nearly all communities provision is made for children who are blind or deaf and dumb.

The sanitation of the school and its environs is a community responsibility and one that is too often neglected. Every school should be built and maintained so that the health and welfare of the children attending it will be improved, not jeopardized, in consequence of such attendance. The building should be properly heated, lighted, and ventilated. An adequate supply of pure water should be available, common drinking cups and roller towels banned, and proper toilet conveniences should be provided. The unsanitary conditions existing in some schools in respect of these requirements, should not be tolerated for a moment, and probably would not be, if mothers and fathers were aware of the actual conditions. Proper desks and suitable seats, no more expensive to install than the undesirable kind, should be insisted upon. Physicians interesting themselves in these matters, and arousing the public conscience, are doing a service of the sort which they are especially qualified to perform and one that is most commendable.

Open-air schools and open-air classes in certain schools, where it is possible to conduct them, serve a most useful purpose in health promotion. Open-air classes are designed to improve the physical condition of children who are undernourished from any cause except that resulting from the presence of defects which have not been, or cannot be, corrected. These classes are especially useful for those children with a history of tuberculosis or of having been contacts of an open case of the disease; or those suffering from chorea.

To the usual class work suitably modified, there is added health instruction, and proper medical and nursing supervision is maintained. These children are given only such class work as they can undertake to advantage and without detriment to their health.

Then good food and extra diet in the way of milk, etc., is supplied. Finally the schedule provides for rest periods and an abundance of fresh air and sunshine and such necessary information on health matters as will aid them to help themselves in their task of building strong bodies capable of resisting infection.

In these classes the children on their arrival at school are given a glass of milk or other extra nourishment if necessary. There is a short rest period or intermission in the morning and at noon a plain but substantial meal is provided. After this, there follows a period for sleep and rest. Then further class work and finally a glass of milk is taken before the children are dismissed for the day. In the open-air classes in the Toronto Public Schools, the average gain in weight for a ten months period was 6¼ pounds, as against the normal gain of the same age group of about 4½ pounds.

In addition to these open-air classes, in certain communities, Forest Schools are conducted during the spring, summer and early fall months for tuberculin-positive, underweight children, and for those suffering from chorea. Children attending these schools have been found, in Toronto, to make gains in weight 60 per cent above the normal, as a result of the healthful conditions under which they are living. Forest schools are less useful, however, than open-air classes in ordinary schools, in many communities, because of climatic conditions which render forest schools unsuitable for five or six months in the year.

A much neglected or inadequately provided part of health work for children of all ages but especially those of school age, is that of health education. This is the result, probably, of neglect of health education of the teachers. Formal instruction of teachers in elementary personal and public hygiene is often entirely overlooked or is of a character that does not appeal to those to whom it is offered. Health teaching for instructors and children alike, should be vitalized, and practice and precept must not be separated. If the teaching is given local coloring by reference to features capable of demonstration in any community, the subject assumes an entirely different aspect. The things that count in health promotion are of the simplest sort, and should not be made complicated or dull in the teaching.

A great opportunity for health work is provided by combining with it suitable recreational measures. Every possible effort should

be made for those children who for any reason have not opportunities or place for recreations, to provide them with such. Playgrounds in larger centers of population are very necessary. But everywhere, teachers should be given the opportunity of learning the elementary facts on which sound health practice is founded, and they should not only hear, but be made to realize, that good health pays both the individual and the community, and conversely, that most of us can have as much good health as we are prepared to work and pay for.

Many voluntary organizations cooperate with the school authorities in the conduct of health crusades and such efforts are most laudable, and deserving of hearty support and encouragement. The Junior Red Cross, the Boy Scouts and Little Mothers' League are all worthy examples of agencies of this sort.

That the knowledge and practice of proper health habits combined with organized community public health work has in the last 50 years added more than 10½ years to the life of the average individual, that the annual crude death rate has fallen from 20 to 12 per 1,000 population per year, and that infant death rates have been cut in half in the same period of time and that typhoid fever, tuberculosis and many other endemic and epidemic diseases are gradually being brought under control; should be made the common knowledge of parents, teachers and school children alike.

Much has been accomplished, and this very fact should be the incentive to press forward and accomplish still more; because, as Winslow has pointed out, there are still many "untilled fields of public health." None of these perhaps, is likely to yield a greater and more abundant harvest than the dissemination of the knowledge of those facts on which good health is based. Such facts taught by demonstration and by actual practice, stimulated by the knowledge of what has been, and can still be accomplished, is the proper method of approach of all those interested (and who is not?) in the promotion of health as well as the prevention of disease. Education in sex hygiene is a very important matter, but there is a general agreement that this is not something that should be undertaken in the primary schools for children between the ages of six and fourteen. Such sex knowledge as is necessary for children of this age group can best be imparted at home by the parents. This does not imply, however, that it should be neglected, quite the con-

trary, and every parent owes it to the child to see that such information is given.

Physicians should be qualified to offer advice to parents, when such is sought, as to how this knowledge may be conveyed in a manner likely to be productive of good. The special problems of the adolescent period can only be referred to here, but it is very important for every one to realize that the young child is going to obtain a knowledge of sex matters from some one, and those children whose source of information has been the parents are very often safeguarded in a way that children who have gained their knowledge of sex matters elsewhere are not.

Many useful pamphlets and booklets dealing with this topic are now available. A most charming essay on the subject is "Adolescence" by Stephen Paget. In addition, two useful publications have been issued by the United States Public Health Service, in which the essentials of sex education are outlined. The following summary from the article on the "Place of Sex Education in Biology and General Science," will serve to indicate the essential features of such instruction.

"What may we reasonably expect as results of sex education in biology and general science? This question has already been considered. Let us summarize some of the points.

"First, there should be a development of the idea that sex in its normal aspect is clean. There has been a confusion of ideas concerning this subject, even among adults, partly because of 'the conspiracy of silence' which has resulted in confusing the minds of many people concerning the normal functioning of the body in health in comparison with its abnormal functioning in disease.

"A second result of sex instruction in biology and general science should be the dispelling of distorted ideas concerning the significance of the physiological changes that are peculiar to puberty and adolescence. The pupil who enters high school almost always has a mass of misleading, if not vicious, information. One of the most beneficial results, therefore, which should follow this kind of instruction would be the correcting of this misinformation and the giving of knowledge, wholesome in its nature.

"Another result of this instruction * * * should be the correcting of mistaken ideas concerning the nature and effects of venereal diseases. The facts brought to light by the wonderful

discoveries in recent years in bacteriology, immunology, and upon the general subject of disease prevention have through publicity been made to render a very great service to mankind. The world can be made safe for posterity through the wise dissemination of such knowledge.

"The results just mentioned are important, but should be considered primarily as means towards the achievement of an ultimate goal. This kind of instruction is of little use unless it leads to actions and the formation of habits that are beneficial. The pupil should understand that he either has already reached or is rapidly approaching a very critical time in his life when he must choose between two possible courses of action which will have a lasting effect upon him. It is the privilege and duty of the trained teacher of biology and general science to point out to him the possible, not to say probable, results of certain lines of conduct and to do everything in his power to assist the pupil in choosing that course which the experiences of the race indicate is the only safeguard and wise one to pursue."

As a result of a conference of representatives of official and voluntary agencies included in what is known as the National Child Health Council, of the United States, the Committee on Health provisions for laws relating to children, drew up the following useful outline of suggested legislative measures and enactments:

"I. PRENATAL CARE

"(A) State children's code commissions should recommend the removal of all legislative restrictions which prevent proper and complete measures for prenatal and maternity care and the granting of positive legislative authority for undertaking and promoting such measures. (*Note:* Examples of legislative restrictions that should be removed are such limitations as to tax rates or levies as make it possible to provide adequate appropriations for the care of the health of mothers and children. Also in some States local authorities are not permitted to undertake certain important measures unless these are specifically authorized by statute. Such legislative restrictions as prevent necessary health measures are apt to be overlooked in drafting health and welfare legislation.) Facilities for the education of expectant mothers, for the establishment of prenatal health centers and clinics, for the protection of expectant

mothers in industry and for the health supervision of mothers should be definitely authorized by law.

"II. CARE AT BIRTH

"(A) *Midwives:* State laws should require that all midwives be licensed by the state health department, for the purpose of permitting only those who are properly qualified, to practice midwifery, and that adequate provision be made for proper supervision by state or local health authorities of all such midwives, to see that they observe all regulations, subject to revocation of their licenses. Educational training of obstetrical attendants and midwives should be authorized only where the facilities for training are adequate and there is proper educational and health supervision.

"(B) *Control of ophthalmia neonatorum ('babies' sore eyes').* Every state health department should be specifically authorized by law to require the immediate reporting of all inflammatory conditions of the eyes of the newborn, to require treatment of the eyes of the newborn at birth, and to furnish prophylactic treatment for this condition in order to prevent blindness. (*Note:* Experience has shown that the law should describe this disease rather than simply refer to it by its technical name.)

"(C) *Vital Statistics:* The law should require the prompt reporting of births by the professional attendant to local registrars of vital statistics not later than three days after birth. Registrars should be under the health department. Legislation requiring the reporting of stillbirths is important.

"(D) *Supervision of Maternal Homes:* All institutions in which mothers are given care during or near confinement should be licensed, subject to the periodic inspection and approval of health authorities.

"III. INFANT AND PRE-SCHOOL CARE

"(A) *Removal of Legislative Restriction:* Legislative restriction should be removed and definite legislative authority granted so that adequate facilities for protecting and promoting the health of infants from birth to the beginning of school age can be provided by state and local authorities. (*Note:* The type of legislation necessary for this purpose, with reference to babies, pre-school children,

and mothers, is indicated under paragraph I-A which deals with the prenatal period.)

"(B) *Control of Milk and Milk Products:* There should be legislation requiring the general pasteurization of uncertified milk, the supervision of such pasteurization, and such other regulation and supervision of the production, handling, and preservation of milk and milk products as will insure a safe supply.

"IV. CARE OF CHILDREN IN SCHOOL

"(A) *Health Education:* There should be legislation providing for the instruction and training of all children of school age, for the purpose of developing health habits through the supervised activities, play, and practical instruction in hygiene, including personal hygiene, nutrition and sanitation.

"Adequate provision should be made for the promotion of health education by the states or provinces in cooperation with local communities.

"Provision should be made for the instruction and training of all teachers in the fundamental principles of health education.

"(*Note:* Such legislation should allow scope for the development of initiative, spontaneity, and responsibility on the part of the child. Rigid and uniform courses of physical drill or hygiene instruction should not be prescribed, but rather there should be the normal stimulation of the child's physical development and the interweaving of health education into all the many subjects of which it naturally forms a part.)

"(B) *Physical Examinations and Health Supervision:* There should be State legislation making it possible for counties, municipalities, and townships to provide facilities for periodic physical examinations and for promoting the health of school children. The appropriate State authorities should be authorized to promote the development of such facilities." (*Note:* The type of legislation necessary for this purpose is indicated under paragraph I-A.)

"It should be required that the health supervision of the school children be closely correlated with the health supervision of babies and pre-school children.

"(C) *Health Classes for Special Groups:* Legislation should authorize facilities for the training and instruction of special groups

which by reason of disabilities, are unable to receive adequate education and health supervision in the regular classes.

"(D) *Sanitation of Schoolhouses and Their Environment:* School buildings, school grounds, and accessories should be regularly inspected and supervised as to the sanitary conditions, subject to the regulations and jurisdiction of the health authorities."

"V. CHILDREN IN INDUSTRY

"(A) *Physical Supervision of Health Education:* As long as a child is of school age he should receive health education and supervision. (*Note:* Experience shows that the continuation school offers an effective medium of health education and supervision.) Physical examinations should be given when he leaves school to go to work, at each change of occupation, and periodically thereafter while he is of school age.

"VI. GENERAL

"(A) *Administration:* In each State there should be a bureau of child hygiene. The administration of all legislative provisions affecting the health of children, except those which properly pertain to other State agencies, should be vested in the bureau. The work of such other agencies and that of the bureau of child hygiene should be properly coordinated.

"(B) *Control of Institutions and Agencies:* All public and private institutions, agencies, courts, and boarding homes caring for dependent, defective or delinquent children should be required by law to have adequate health supervision over their work and wards, subject to the regulations of the health authorities.

"All measures dealing with the appropriation and expenditure of funds for material relief in connection with child or maternity care should specifically make provision for adequate care of the health.

References for those who are studying child hygiene and welfare legislation

It is recommended that the following references be consulted:

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Model State Law for the Registration of Births and Deaths. Supplement No. 12 to the Public Health Reports, pp. 83-92, United States Public Health Service, Washington, D. C.

Model State Law for Morbidity Reports. Reprint No. 285 from the Public Health Reports, United States Public Health Service, Washington, D. C. Report of Committee on Model Health Legislation. American Public Health Association, 370 Seventh Avenue, New York City.

State Commission for the Study and Revision of Child Welfare Laws; Publication No. 71, Children's Bureau, United States Department of Labor, Washington, D. C. Recent State Legislation for Physical Education. Bureau of Education, United States Department of the Interior, Washington, D. C.

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CHAPTER XX

PUBLIC HEALTH CLINICS AND HEALTH CENTERS, AND RURAL HYGIENE AND PUBLIC HEALTH

The ever-increasing scope of work undertaken by departments of health and associated or allied agencies has been one of the most interesting developments of the past five or six decades. As never before it has come to be realized that everything which promotes health is a paying investment. Interest in, and encouragement of, education and health are the real indications of an enlightened civilization.

The present movement for general amelioration of the conditions under which many people live, had its beginnings in an effort to offset the evil consequences of overurbanization consequent upon the industrial revolution. This began in England about the middle of the 19th century. The concentration of population, in the relatively important towns resulting in overcrowding and insanitation, was one result of the enormous industrial expansion of that period. Coincident with overcrowding and bad housing, there was no effort made to supervise conditions of industrial employment. In consequence, overwork, undernourishment due to economic degradation, and all the attendant domestic, and a great volume of general, ill-health prevailed. As Sir Arthur Newsholme has pointed out in his discussion of public health progress in England during the last fifty years: "It was assumed that given free competition, enlightened self-interest would incite effort and improvement, encourage self-reliance, and guarantee production and economy. Under the conditions inevitable with such teaching although great wealth accompanied the rapid industrial development after the Napoleonic Wars, it was associated with unrelieved misery; for home workers and rural workers crowded into mean hovels in towns, paying exorbitant rents out of miserable pittances of wages, and were exposed to the evils resulting from overcrowding, and from absence of adequate and satisfactory water supply, scavenging or drainage. By the year 1857 about half the population of England and Wales had

become aggregated in towns; and it may be added that in 1911 less than ¼ of the population was left in the rural districts."

Beginning about 1880, in all the older countries where industrial development for the succeeding fifty years was rapid, very many people became indoor instead of outdoor workers, and city and town, instead of rural dwellers. As a result of this, death rates were excessive, and all transmissible diseases spread with great rapidity among practically all the people. No effort was made to check them, with the single exception of smallpox.

In England, legislative reforms aimed at the correction of industrial abuses preceded efforts to improve health conditions. Measures to regulate the hours and conditions of employment and to protect women and children in industry were passed in 1802. Subsequent factory acts of 1819, 1833, 1844 and 1847, limited the hours of labor, and led to improvements in the conditions existing in industry, at the time. There followed efforts to aid the suffering, the destitute, and those just on the poverty line. The time was now ripe for consolidating and extending existing public health legislation, and in 1875 England's great sanitary code was enacted.

Measures prior to 1875, for the betterment of conditions affecting the health of the people, were limited chiefly to the collection and tabulation of vital statistics, and to the improvement of sanitary conditions, by the introduction of means of providing for communal supplies of pure water; of disposing of sewage and other waste matter of large cities, and ensuring clean and wholesome surroundings from street-cleaning, municipal lighting, satisfactory ventilation of dwellings and other buildings. These were the chief activities. Filth and disease were associated because the causes and modes of transmission of communicable diseases were then not understood. This was the period of the initiation of control of controllable factors in the environment, which may deleteriously affect man's health and welfare. Sanitary reform began to come into its own.

Next followed the bacteriological era. Between 1880 and 1905, in a period of about twenty-five years, the causes of a large number of the communicable diseases were discovered, and the methods of their transfer elucidated. During this period also, knowledge of the greatest importance was gained in regard to the specific control and treatment of certain diseases, by means of antitoxins and serums. That is, the science of immunology, or specific disease pre-

vention, began to be developed. Zealous attempts to control communicable diseases in addition to general sanitary efforts marked this epoch. The endeavors of a few individuals to stimulate general interest in personal health measures, and to spread the knowledge of sound health practices, were neither systematic nor continuous.

During the past fifteen or twenty years *health promotion,* as well as *disease prevention,* has made great strides. Individual interest in, and knowledge of, conditions affecting health and well-being, have been developed by public health departments, voluntary agencies, great corporations such as insurance companies, and indeed by all who firmly believe that the happiness and prosperity of any race or nation is conditioned, in the first instance, on the possession, by the majority of its citizens, of good health.

Adequate provision of institutional facilities for the care of the sick, the poor, and the infirm by establishing hospitals, hostels, etc., had been the task, first of the Church, and then of municipalities, etc., since 325 A.D. Never in this long past, however, until within the last decade or two have organized efforts been made to create machinery for determining the physical and mental status of great groups of the population, and to provide, further, not only for the treatment of the sick, but also for the maintenance in good health of those not yet afflicted with any disability.

It is an exploded superstition that, in China, a medical profession organized for the protection of health, exists. Nowhere until the beginning of the twentieth century, have systematic, organized community efforts been made to take stock, physically and mentally, and to provide the means whereby defects may be remedied, and adequate individual preventive efforts developed and encouraged.

School medical service led the way. Examination of pupils in primary classes stimulated interest, and soon dental and nursing service was added. The knowledge of the volume of disability in children of school-age increased. Demands for the examination of groups of adults arose, then the Great War necessitated a physical stock-taking, the like of which has never before been witnessed.

The number of men found to be suffering from preventable or remediable disabilities was enormous. Furthermore, the preliminary examinations, supplemented by general supervision of health, the adoption of specific preventive measures, and adequate health educational work, resulted in deaths and disabilities from prevent-

able causes being reduced to a point never before deemed possible. All of this had its effect in stimulating the movement for what had already gained impetus even before the War. More adequate facilities were demanded for the early detection and alleviation of remediable defects; for supervision of those exposed to unusual health hazards, for the discovery and elaboration of means of lessening the volume of mental abnormalities and subnormalities; and finally, for the diagnosis and early treatment, (at the expense of the state if necessary) of those suffering from diseases known to be a great menace to the well-being of the race. It was realized, too, that much of this would probably have to be done at the expense of the community.

Advances in medical science have been very great and so varied that a high degree of specialization has resulted, and the need of careful and often elaborate, combined clinical and laboratory investigations, in many cases, has made it impossible for all but the very rich, to provide for such a service, at their own expense. For those of very limited financial resources, or the poor, facilities have ever been accessible at the public expense, owing to a recognition of the close relationship existing between disease and poverty; and for broad humanitarian reasons.

With the growth of modern public health departments the need of providing health supervision for all in the community who wish to avail themselves of such a service, in addition to the work originally developed by them, has led to the establishment of what are now known as public health clinics or health centers. Members of the community whose economic status renders it possible, however, are likely to choose their own physician as their health supervisor, rather than demand that this service be provided at the public expense, in such clinics or health centers.

Health supervision should begin with the expectant mother; be continued through infancy; and carried on through the pre-school period, and later during the years of school life. Nor should it cease even then, but by means of periodic medical examinations, be continued until the end of life. Keeping patients well, rather than treating the sick, should be more and more the character of the physician's efforts.

Any attempt entirely to dissociate or separate the functions of treating the sick and promoting good health, at one and the same

time, and in one and the same place, is unsound and undesirable. For those who seek him in time of sickness, the physician's office should be a health center, available for the purpose of health promotion and disease prevention, through examination, advice and teaching. By such teaching, the value of antenatal care, of infant and child-age supervision, and periodic medical examination, will be comprehended by the patients who come under the care of the private physician.

It is difficult to overemphasize the importance of the physician carrying on public health educational work among his patients. Advice as to how to avoid infection should be given and the necessary measures positively to promote good health outlined. This can be done by stating in simple terms the elementary facts of personal and public hygiene. The occurrence of a case of a cold may be used to illustrate the method of transmission of communicable diseases. No amount of effort by the community through public health workers or specially trained persons will be of any avail, unless the great mass of the people is educated in the essentials of healthy living and desire to cooperate in public health work which is essentially in their own interest.

Then, too, the physician should keep careful case-records, however brief they may be. Patients requesting examinations and health supervision are entitled to adequate service, and this they cannot receive if the physician keeps no records. Results of urinalyses, blood pressure determinations, etc., should always be included in these records. Then, too, the physician must examine patients coming for periodic examinations, carefully and thoroughly. They should be encouraged and not treated with amused tolerance. Even patients with a tendency to magnify their own minor ailments will benefit by a complete examination, and some sound advice on how to live a normal healthy life.

For the sick of all classes, the hospital should be a health center. Not only should it be a place where treatment is given, but also one where health promotion is actively carried on. Health center work can, and indeed is at present, effectively conducted in the antenatal, child hygiene, mental hygiene, tuberculosis, venereal disease, and other special clinics in many hospitals. Prevention and treatment should go hand in hand, whether in hospital or private practice. The well-trained physician is qualified to employ any and all meas-

ures essential in this work. For his aid, and to supplement his clinical examinations, the facilities of hospital and public health laboratories, for routine diagnostic and special work, are available. Modern ideas demand that the physician shall be as interested in health promotion—that is, the practice of preventive medicine—as in the treatment of the sick, or curative medicine.

The organization of clinics and centers for public health purposes, and the methods of conducting work therein, are elaborated in a series of special articles in the appendix. Also the importance of medical nursing and dental service in schools and the organization and conduct of such service is considered in another article in the appendix. The health work in the schools is taken advantage of by the vast majority of all children between six and fourteen years of age in the community. The ever-widening influence of this will be felt more and more in the future. Children of the present generation, the men and women of tomorrow, are gaining an effective insight into the value of routine medical examinations and inspections, and an appreciation of this health work in the future is likely to be very general.

In addition to the clinics conducted for the special purposes already indicated, arrangements have recently been made in many places for the routine, or periodical examinations of persons presumably healthy, for the purpose of detecting any disease process in its earliest stage. Examinations of this sort have been conducted among employees of municipalities and of various corporations, also among policy holders of certain insurance companies, and among groups and individuals in the community at large, in connection with the activities of organizations such as the Life Extension Institute. These examinations may be made in a special clinic or center, or in a general medical clinic, or in the physician's office. Access to diagnostic laboratory facilities is essential, in order that clinical findings may be supplemented by the addition of the results of any necessary laboratory investigations.

What are the advantages likely to accrue from such periodical examinations, and what special defects may be thus detected? One of the most important and the first on the list of causes of death, is organic heart disease. In the United States, it is estimated that 2,000,000 men, women and children are suffering from diseases of the heart—an average incidence of about 2 per cent. According to

the mortality statistics of the insurance companies, persons impaired with heart disease suffer from a death rate which is at least twice the normal for their ages. Even persons with lesions such as well compensated mitral regurgitation, show a mortality twice that expected at their ages. "Heart disease causes a curtailment of two years in the life expectation of females, and of one and one-half years among males." This is a most fruitful field for work in preventive medicine, the early detection of heart lesions, and the supervision of patients individually or in cardiac clinics or classes, by regulation of occupation, further control of acute febrile conditions, the removal of foci of infection, etc., should result in a saving of lives, in this group. This is a most satisfactory prospect for the practitioner of preventive medicine and the community at large.

A very important additional reason for the conduct of routine medical examinations from infancy to adult life is, that it should invariably precede physical education, exercise, indulgence in athletics, etc.

This is now clearly recognized in practically all fields of competitive athletics. Universities, colleges, and other organizations, usually demand a thorough medical examination, prior to a candidate's entering any branch of athletics, and furthermore, systematic supervision of those so engaged is provided.

The value of physical education, of play, of properly supervised competitive games, from the standpoint of physical and mental well-being is now generally appreciated. Sir Leslie Mackenzie, in an interesting article on physical education in relation to health promotion has written: "Physical education is a mental process. Every voluntary movement is a mental action. Every thought has its physiological concomitant. The training of the muscles is as much a mental process as the training of the intellect or the will. It is always the living person we have to educate. If he would meet the illimitably various demands of life, he has to be sound in all organs, yet enduring; to be adaptive, yet reactive; to be supple, yet strong; to be alert in action, to be capable of acting without hesitation on a given emergency; to be capable, in a crisis, of mobilizing his whole strength without conflict of motive or failure of control.

"To achieve these ends is the purpose of physical education. So conceived physical education becomes a training in the dynamics of

character. * * * But if it be the case that physical education is a mental process, a special factor in the development of the will, it is obvious that it becomes a primary instrument in the maintenance of health, and in the prevention of disease. But to yield its full fruit, physical education must be adjusted in kind and degree to the capacities of the individual person. This implies that the person comes to his physical education only after the most intimate medical scrutiny. This in turn means that, so far as practicable, the person, whatever defects or ailments he suffers from, shall be physically educated towards his own physiological normal. But to secure this we must have an exhaustive system of medical inspection and such treatment as the inspection indicates.

"Physical education as thus understood, becomes a fine instrument for the promotion of healthy growth, for the prevention of incipient disease, and for the treatment of many physical ailments and defects. But one precaution is fundamental; when growth is rapid, the margin for training is small. Subject to this qualification, there is a physical education subtle enough to be adapted to every stage of growth from infancy to old age. From beginning to end, it is the heart and vessels that we must think of most, * * * physical education may make all the difference between a healthy progress, and an unhealthy one."

The relationship of physical education and exercise to health is thus outlined in general terms; but what is essential from the standpoint of the practitioner of preventive medicine, is a knowledge of what measures will benefit a given patient; what the tests of physical fitness are; and how a person may be directed or guided to develop along physiological lines. This is difficult at the moment to indicate specifically.

For a number of years much effort has been put forth to establish standards of fitness for individuals of different age periods. Mention has already been made of the use of age, weight, and height tables in infant welfare work. But additional standards are necessary, based on physiological laws, which will enable the physician to ascertain the degree of physical fitness of an individual of any age or occupation. Vital capacity, or the relationship of this, to weight, the so-called vital index, has been regarded as having considerable value for the purpose. However, the investigations of G. Dreyer have shown "that in healthy individuals, definite rela-

tionships exist between vital capacity and body surface, body weight, trunk length and chest measurement. * * * The relationships so established by the examination of individuals in perfect physical health provide a standard of physical fitness with which any given individual can be compared." (Mackenzie.) These results of Dreyer are to be published by the Medical Research Council in England and obviously will be of the greatest possible value to the physician in his efforts, through periodical medical examinations, to assess the physical condition of any patient. They are to be sufficiently comprehensive to indicate standards of various classes of occupation and condition. If these formulae justify expectations, then, for the first time, a method of ascertaining the degree of fitness at any age, will be available.

The suggested periodical medical examinations will for many persons, in any community, probably have to be provided at the expense of the community in clinics, dispensaries or health centers. This work, like other public health efforts, will pay a very satisfactory return on the investment. The addition of one year of life to the average individual or a reduction in time lost from sickness by the average wage earner (about 2 per cent on the average) would more than reimburse the community. In the United States an annual monetary loss in wages on account of sickness has been estimated to be not less than $700,000,000. Periodical medical examinations and health education, resulting in the adoption of healthy habits of living would result in a great reduction of this enormous loss.

These examinations will probably bring to light many previously unknown cases of tuberculosis. This has been demonstrated by the work of the Framingham Tuberculosis Demonstration. The examination of thousands of people there has revealed the fact that about 1 per cent of those examined were suffering from active tuberculosis. Furthermore, it has been found that these routine medical examinations provide the most useful medical machinery for the early discovery of cases of this disease, if combined with the medical services in schools and industrial plants, and a well organized consultation service. In Framingham, before the commencement of the demonstration, physicians saw cases of tuberculosis in the early stages in about 45 per cent of instances; now as a result of these examinations, 83 per cent are found in an early stage of the disease.

Routine medical examinations should be supplemented by similar

dental examinations and provision for the necessary treatment and correction of defects. Mouth hygiene is extremely important and work should begin with the expectant mother. The importance of this is emphasized by Sir Leslie Mackenzie, who describes a case in which an infant could not be breast-fed until after the mother had received certain much needed dental care, but readily and promptly took the breast subsequently. The mouth of the infant must receive careful attention, and later the teeth of children of pre-school and school age and those of adults require periodic supervision. Similar provision for dental clinics as outlined for various other public health centers or clinics should be made. Every hospital conducted to function as a health center should have a dental clinic. Physicians have an opportunity of which they should avail themselves, of impressing upon their patients the extreme importance of proper dental supervision.

The economic burden of mental disease and deficiency in any community is illustrated by the following facts, as they relate to the Province of Ontario. In the year 1919, in the Province, there were 7,475 patients in hospitals and institutions for the insane, epileptic, and defective. At the same time, there were only 6,689 patients in all general hospitals in the Province.

The total admissions to the institutions for the insane, etc., for that year, were 2,850, and discharges only 842, indicating the large excess of admissions over discharges. The total maintenance cost of these 7,475 patients for the year was $1,748,545.28, of which the Province provided $1,196,221.67. The total Provincial expenditure for educational purposes in the same year was $3,302,487. In other words, the people of the Province of Ontario in 1919 spent half as much for the care of the mentally abnormal and subnormal, as they did for all educational purposes.

On the basis of expediency alone, the necessity for more widespread and intensive efforts along lines of mental hygiene is quite evident. The importance of mental disease as a cause of death is little appreciated. The Bureau of Statistics of the National Committee for Mental Hygiene has ascertained that for the year which ended June 30, 1919, 30,000 deaths occurred among inmates of institutions for the insane in the United States. The experience of a large industrial insurance company has indicated that only about one-half of the deaths from mental diseases occur in institutions

for the care of the insane. If this is generally true, then there are at least 60,000 deaths among insane persons, in one year, in the United States.

One of the most serious problems of preventive medicine at the present time is that of cancer. Hoffman, who has made a most thorough study of cancer mortality statistics, has concluded that there is evidence of a very definite increase in the cancer death rate everywhere, and it is one of the most serious menaces to health, at the present time. In the registration area of the United States in 1919, deaths from cancer and other malignant tumors, to the number of 68,551 were registered. This was equivalent to a rate of 80.5 per 100,000 of population, and 6.3 per cent of all deaths recorded in registration area for that year. Cancer was sixth on the list of causes of death for 1919. At ages over forty, cancer is the cause of 1 in 8 deaths among women, and 1 in 14 among men.

The loss in years of average lifetime due to cancer and other malignant tumors has been ascertained for wage earners insured in the Metropolitan Life Insurance Company. Covering the period 1911 to 1916 among many million policy holders it was found "that at birth the expectation of life of white males was reduced about three-fifths of a year, and that of white females nearly two years. The maximum loss in expectant life for white females occurs about age thirty-five. After age twenty-five, cancer causes a greater loss in expectation of life for white females than tuberculosis."

The chief hope of favorably influencing the present cancer death rate is through a widespread educational campaign and by periodic medical examinations to ensure the detection of the disease in its very earliest stages. Physicians should make it known that early in the disease, cancer may give rise to no pain, or occasion no pronounced subjective discomfort. Patients should know also, that any lump or tiny hard spot in a woman's breast, especially after forty years of age; that any uterine hemorrhage, however slight or trivial after the menopause, any wart or new growth or sore on the tongue or lip of a man over forty-five, especially; a history of hemorrhage from the bowel in men or women after forty-five; or any apparently harmless new growths, such as warts, moles, etc., which suddenly begin to increase in size, are all danger signals, and a physician should at once be consulted. The necessity of avoiding irritation of the tongue or cheeks by stumps of teeth or pipes should also be

emphasized. It is most essential that the general public be made to realize, too, that prompt surgical treatment is the only method at the present time of reducing the cancer death rate. Periodical medical examinations should materially assist in the early recognition of cases of this disease, and consequent reduction in cancer mortality.

In addition to the detection of early symptoms of organic heart disease, of tuberculosis and of cancer, periodical medical examinations would render possible the recognition of slight disturbances in renal functions, before such had become a grave menace to the patient. Acute nephritis and Bright's disease were given as causes of 75,005 deaths in the registration area of the United States in 1919; a death rate of 88.1 per 100,000 of population and 6.8 per cent of all the deaths. These conditions were fifth on the list of causes of death for that year. Recently a study has been made by the statistician's department of the Metropolitan Life Insurance Company, of the subsequent mortality of persons rejected for insurance, because of the presence of albumin, or albumin and casts, in the urine.

Among a group of 2,000 rejected applicants showing persistent presence of albumin in the urine, the mortality was twice as great as that experienced on unimpaired lives, and a mortality 24 per cent in excess of that anticipated, according to the American Experience Table. The gravity of impairment was found to increase with the age of the person at the time of the examination, and, with the quantity of albumin found. Those under age forty, with a *faint trace* of albumin, gave an excess of 8 per cent; over age forty, faint trace, excess of 32 per cent. Those having *a trace*, under age forty, gave a 9 per cent excess mortality, and over forty an excess of 131 per cent.

Among a group of 3,000 rejected applicants, cases showing albumin and casts, had the following experience: Under age forty, faint trace of albumin and casts, excess mortality 19 per cent. Over age forty, faint trace of albumin and casts, excess mortality 39 per cent. Under age forty, trace of albumin and casts, excess mortality 48 per cent. Over age forty, trace of albumin and casts, excess mortality 124 per cent.

That is, those with a trace of albumin and casts had a mortality about 3 times as great as expected, according to the American Experience Table. Bright's disease as a cause of death was 8 times greater than normal, among the first group, and fifteen times greater

than normal among those of the second group. Finally, in the second group, organic heart disease was four times greater than normal as a cause of death, as were also cerebral hemorrhage and apoplexy, as causes of death. Periodical medical examinations (including urinalysis and blood pressure determination) would have indicated very early the need of instituting suitable prophylactic measures, such as the removal of possible foci of infection, regulation of the diet, recommendations in regard to exercise, rest, etc., which would probably have favorably influenced the future course of a number of these individuals.

The physician may suggest the adoption of a simple set of rules of elementary personal hygiene which, if carried out in practice and combined with periodical medical examinations, will do much to promote good health. Such a set of rules has been outlined in the pamphlet, "The Road to Health" issued by the United States Public Health Service, these rules are:

Rules of Hygiene

1. Ventilate every room you occupy.
2. Wear loose, porous clothing, suited to season, weather, and occupation.
3. If you are an indoor worker, be sure to get recreation outdoors.
4. Sleep in fresh air always; in the open, if you can.
5. Hold a handkerchief before your mouth and nose when you cough or sneeze, and insist that others do so too.
6. Always wash the hands before eating.
7. Do not overeat. This applies especially to meat and eggs.
8. Eat some hard and some bulky foods; some fruits.
9. Eat slowly—chew thoroughly.
10. Drink sufficient water daily.
11. Evacuate thoroughly, regularly.
12. Stand, sit, and walk erect.
13. Do not allow poisons and infections to enter the body.
14. Keep the teeth, gums, and tongue clean.

The accompanying average height, weight and age table (LXXXI) for men and women which is included in the above publication may also serve a useful purpose in roughly determining overweight and underweight in adult patients.

Reference has been made in the chapter on venereal diseases to the necessity for organized community effort to reduce the incidence of syphilis and gonorrhea. The physician should be familiar with

TABLE LXXXI

AVERAGE HEIGHT, WEIGHT, AND AGE FOR MEN AND WOMEN

(For a man add 2 pounds to the average; for a woman, subtract 2 pounds.)
(If you are more than 25 pounds below the average for your height and age, you are thin and probably undernourished.)

FEET	INCHES	AGES							
		15-24	25-29	30-34	35-39	40-44	45-49	50-54	55-60
5	0	120	125	128	131	133	134	134	134
5	1	122	126	129	131	134	136	136	136
5	2	124	128	131	133	136	138	138	138
5	3	127	131	134	136	139	141	141	141
5	4	131	135	138	140	143	144	145	145
5	5	134	138	141	143	146	147	149	149
5	6	138	142	145	147	150	151	153	153
5	7	142	147	150	152	155	156	158	158
5	8	146	151	154	157	160	161	163	163
5	9	150	155	159	162	165	166	167	168
5	10	154	159	164	167	170	171	172	173
5	11	159	164	169	173	175	177	177	178
6	0	165	170	175	179	180	183	182	183
6	1	170	177	181	185	186	189	188	189
6	2	176	184	188	193	194	196	194	194
6	3	181	190	195	200	203	204	201	198

the principles underlying the campaign against these diseases. The place of the public-health venereal disease clinic, in this effort, is outlined in the article in the appendix dealing with the organization and operation of such clinics.

As a private practitioner he may take an active part in the movement by assisting in developing a healthy public opinion in support of the different aspects of the measures now being promoted. These are:

(1) Suitable medical provision, clinics, diagnostic laboratories, etc. (2) Adequate law enforcement—this includes notification of cases, warning patients of the danger or menace they may be to others; the hazards of irregular sexual relations, detection of sources of infection; use of social case sheet, etc. (3) Vigorous educational propaganda may be carried on by the health departments or voluntary agencies, but it requires the cordial and general support of physicians in private practice in order that it may succeed. The importance of such activities has recently been emphasized, indirectly, in an article by Kirby, dealing with the significance of alcohol and syphilis as causes of mental disease. Kirby points out that psychoses due to syphilis, in New York State, reached the highest

point on record in 1918; since then there has been a decline in the actual and relative number of cases. The data in regard to this are brought out by Kirby in Table LXXXII which includes also record of alcoholic psychoses.

TABLE LXXXII

RATE PER 100,000 OF GENERAL POPULATION OF NEW YORK STATE OF ALCOHOLIC PSYCHOSES AND PARESIS

YEAR	ALL PSYCHOSES	ALCOHOLIC PSYCHOSES	PARESIS
1913	64.1	6.0	8.1
1914	65.4	4.8	8.1
1915	64.0	3.6	8.4
1916	66.5	4.0	8.7
1917	69.0	6.0	8.7
1918	67.3	3.5	9.0
1919	66.3	2.6	8.6
1920	63.3	1.2	7.9

Among 2,540 industrial policy holders, of a large insurance company, who had suffered from an attack of mental disease and in whom the cause of death was investigated, syphilis was found to be the most important.

In reference to the question of alcoholism and insanity, Kirby writes: "Alcoholism has declined in the general population during recent years, the beginning of the decline antedating by some years the restrictions due to war conditions, and the passage of the federal prohibition amendment. Coincident with this there has occurred a remarkable fall in the number of alcoholic psychoses, the lowest figure on record (in New York State) having been reached in 1920." The importance of these facts in reference to mental hygiene is evident. The duty of the physician as a practitioner of preventive medicine is to make them known.

RURAL HYGIENE

The rural health problems of any country are often more difficult to solve than those of towns and cities. This is due to two causes, first, organized public health is often conducted on a more meagre scale in rural than in urban districts; and in the second place, hospital and dispensary facilities with their public health clinics, etc.,

are usually not available, and medical, nursing and dental service is often quite inadequate.

There are no satisfactory statistics to indicate the comparative death rates in rural and urban populations in different countries or states. However, the Statistician's Department of the Metropolitan Life Insurance Company has shown that persons living in rural districts in the United States have a larger expectation of life than persons living in the cities. Rural males in the United States have an average expectation of 1.8 years more than city males, and rural females 1.3 years more than females resident in cities.

It will be seen elsewhere, that infant mortality may be lower in rural than in urban centers. When, however, allowance is made for differences in social condition, economic status, race, etc., the difference may be slight. In the Province of Ontario rural infant death rates are lower than urban death rates. Tuberculosis crude death rates are higher, in Ontario, in rural communities than in cities, but lower than in towns of 5,000 to 10,000 population. In the United States, according to Lumsden of the United States Public Health Service, "tuberculosis is appallingly common in our average farming community."

In rural communities in the Southern United States, hookworm and malaria are chiefly of rural origin. In many communities, typhoid fever and other gastrointestinal disease of microbic origin are more prevalent in rural than in urban districts.

In the vast majority of rural communities, there is but meagre provision made for the fundamental community needs in the way of public health machinery which will provide for supplies of pure water, for sewage disposal, for milk and food supervision, and for public health nursing service. There are also lacking facilities for the conduct of both preventive and curative medicine, in the matter of hospitals, clinics, dispensaries, etc., with their social service departments.

Lumsden has pointed out that rural surveys made in the United States in 1914-1915 and 1916, of 50,000 typical farm homes showed that only 1.22 per cent were provided with sanitary toilets. In 68 per cent of these homes, the water supply, which was used for domestic purposes, was exposed to contamination from privy contents, etc. In only 32.88 per cent were the dwellings screened. Control of communicable diseases was also found to be very inadequate.

Provision for medical, dental and nursing service, in schools in rural communities, is just being initiated. Very few rural communities have any conception of modern public health possibilities, so the physician, health officer and public health nurse, have important duties to perform in first stimulating and arousing interest in health matters, in rural districts, and then in participating in the work itself. Whatever unit of political organization is chosen, for the purpose of public health administration in rural areas, it is first necessary to carry on an intensive campaign of public health education and publicity, and have a survey made of the needs of the community in order to provide for the following minimal requirements set forth by Lumsden:

(1) Opportunities for teaching the facts relating to the cause, methods of spread and means of prevention of the communicable diseases, and the enforcement of necessary quarantine and other regulations.

(2) Instruction by physicians (cooperating with the local health department or as private practitioners) of mothers in antenatal care and supervision and the need therefor. Public health nurses can arouse interest in, and develop a sound public opinion in regard to, the need for this by lectures, talks, etc., in meetings of women's organizations and clubs. In a similar fashion, infant and child hygiene work should be encouraged and promoted in every way possible, and carried on by the methods most suitable for local needs. Every physician in practice in rural communities, should be entirely competent to do satisfactory antenatal and child hygiene work.

(3) Provision for school, medical, dental and nursing work should be made and physical training should be included in this. The sanitation of schools and other public buildings should not be neglected.

(4) A proper water supply and a sanitary privy are essential in every rural home.

(5) Some effort should be made to develop a local health organization in which physician and representative citizens could establish some sort of local center, to provide for a public health and district visiting nurse, for bedside care. Public health educational work could also be carried on in the homes at mothers' meetings and elsewhere. An arrangement should be made whereby contacts of cases of tuberculosis may be examined early, and proper measures instituted. The most hopeful method of attack on the rural health

problems is through the educational and demonstration work among mothers and children in the schools. Lumsden emphasizes the fact that in a conference of state health officers to discuss rural hygiene and public health "there was no optimism about the teaching of old farmers new hygienic tricks, but it was thought that the school children with instruction in hygiene might, upon becoming grown-up, apply their hygienic knowledge." It is very vital that a start be made in this field in all communities, and well trained physicians capable of participating in the movement are essential for its success.

Public health is purchasable in rural as in urban centers. Forceful public health educational work and propaganda by physicians, public health officers, and public health nurses by demonstrations and lectures will make this known, and then more and better public health work, in rural communities, will result. The most hopeful field in which to make a start is health promotion in maternity, infancy, and early childhood, and among children in the schools. Almost the world over, agriculture is the basic industry of the people; good health is not, however, the universal possession of those who live in rural communities, but further efforts will doubtless result in a great amelioration of the condition of life of many mothers and little children, especially, who dwell there.

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CHAPTER XXI

AIR AND VENTILATION

By H. M. Lancaster, B.A.Sc.

Air has long been recognized as one of the essentials of human existence. In early times there were no air supply problems. Air was said to be "free for all," and in fact did cost nothing. Under modern conditions of living it is by no means a simple matter to provide a continuous supply of air which is clean and satisfactory in other respects. In fact we have many circumstances in which a good air supply *must* cost something. Chemistry, physics, biology and physiology have all contributed to the present day knowledge of air and of ventilation. The engineering and the medical professions are applying this knowledge to various lines of practice. Public health organizations have had their attention drawn to these matters not only because of the increase in communicable respiratory disease which follows overcrowding, but also because of the repeated demonstrations of the great value of the open air treatment of tuberculosis. Industrial hygiene is now making rapid progress and is showing the ultimate advantage which a nation derives from the increase in production and the decrease in the wear and tear on the human organism which follows improvement in factory and workshop conditions especially along the lines of dust control and other features of good ventilation.

It is instructive to note some of the prominent features in the history of this subject. Long before the art of microscopy was developed, and when bacteriology was an unknown science, the composition of the air was investigated by the methods of chemical analysis. For many years carbon dioxide was regarded as poisonous; depreciation of the oxygen content of the air in inhabited rooms was also thought to be an important factor. No doubt the widely read description of the "Black Hole of Càlcutta" and the "Grotto del Cane" helped to impress this. But it is found that such conditions are highly exceptional and do not ordinarily occur. Carbon dioxide is not poisonous in the ordinary sense of the term and the oxygen content of the air of rooms is never lowered very much. The discomfort experienced in crowded rooms is caused by the con-

dition of the air as regards humidity and lack of circulation, rather than by any specific poison given off by the human body.

Gases from sewers and badly ventilated drains may cause disgust but are not poisonous and contain very few bacteria. Sewer gas is not directly responsible for the transmission of disease. It has been shown that malaria is caused by a parasite with a complicated life cycle and is conveyed to man by the mosquito, not by any poisonous constituent of swamp air. Diphtheria is not transmitted by the gases from defective drains; typhoid fever is transmitted by direct contact, carriers, water, food and flies but not by aerial emanations. In fact disease-producing microorganisms are not carried as a rule in the air, except in heavy spray ejected from the nose and throat during sneezing and coughing. Considering these facts it is not surprising to find that ventilation was at one time in danger of receiving little attention from public health workers who regard it as a problem concerned essentially with the health of the individual. The work of several important Commissions, and the advancements in knowledge of the subject generally, have helped to alter and improve that view.

COMPOSITION OF THE ATMOSPHERE

The atmosphere is essentially a mixture of various gases and carries variable amounts of water vapor depending upon the temperature and degree of saturation, and solid particles. There is what might be termed a universal dust possibly of volcanic origin present in all air, especially in the lower layers of air at the surface of the earth. Pure dry air has the following composition:

(% by vol. at 0° and 760 mm.)

Oxygen	20.9
Carbon Dioxide	0.031
Nitrogen	78.09
Argon and other rare gases (Neon, Krypton, Xenon, etc.), belonging to the same group	0.94

In addition to these constituents, the air of inhabited districts, especially in cities, may contain chemical compounds such as ammonia, nitrites, sulphur dioxide, sulphur trioxide, carbon monoxide, etc.; dust particles are more numerous in such localities and are

accompanied by bacteria, pollen grains, yeasts and mold spores. It is not known that argon and related elements have any bearing upon health problems but the other constituents should be considered in detail. Elemental nitrogen is comparatively inert and serves as a diluent for the oxygen. It passes through a complex series of chemical changes and plays a vital part in the life processes of plants and animals. Ammonia and oxides of nitrogen are the most commonly occurring nitrogen compounds in air.

OXYGEN

The oxygen content of the atmosphere is not exactly constant at all places, although the deviations from the average are small. The air at sea and over forests has been found to contain 20.98 per cent oxygen; for the air of a city street, 20.87 per cent is recorded, while the lowest figure given for a crowded tenement is 20.6 per cent. This gas is essential for the respiration of man and for the process which is ordinarily referred to as combustion. The addition of one or two per cent of oxygen greatly increases the vigor of combustion. A candle is extinguished when the oxygen content drops to about 16 per cent. Animals begin to experience discomfort when the limit of 12 per cent is reached. Such large variations are not encountered in the air of ordinary dwellings and the human respiratory organs are so constructed and operated that there is ready accommodation to practical conditions. The respiratory exchange in man has been the subject of considerable study. The average adult, with 18 respirations per minute, takes in and expels from 250 to 400 cubic feet of air in twenty-four hours. The tidal volume is ordinarily from 300 to 500 c.c., a residual 2800 c.c. remaining in the lungs.

	INHALED AIR	EXHALED AIR
Nitrogen	79.0	79.5
Oxygen	20.9	16.0
Carbon Dioxide	0.03	4.4
Other Constituents	0.06	0.1
Water Vapor	variable	saturated

The exchange of gases in the lungs does not appear to be explained entirely by the difference in partial pressures in the lung cells and in the blood. It is probable that there is enzyme action as well.

CARBON DIOXIDE

VARIATIONS IN THE CARBON DIOXIDE CONTENT OF THE AIR

	PARTS PER 10,000	
Purest Country Air	2.2	
Average Country Air	3.0	
City Streets	4.0	5.0
Lecture Room (fairly well ventilated)	8.0	10.
Crowded Court Room	20.	
School Room (badly ventilated)	72.	
Sleeping Cabin on Canal Boat	95.	
Mines (Average 339 analyses)	78.5	
School Room before opening	7.2	
School Room 1 hour after opening	29.5	
School Room 1.5 hours after opening	32.0	

Animals can live in an atmosphere containing as much as 25 per cent of carbon dioxide, provided the oxygen content is raised to 30 to 40 per cent. Carbon dioxide is not to be regarded as poisonous. Industrial workers in fermentation industries often maintain perfect health for years although the air near the vats may contain 2 per cent of carbon dioxide. In submarines, a 3 per cent limit is often reached. Divers frequently operate in 1 per cent carbon dioxide. Under these conditions where there is altered pressure, the partial pressures of the various gases present are as important as the percentage content of the carbon dioxide. The carbon dioxide content can therefore be taken only as an index of "vitiation," that is, as a means of judging to what extent air has been re-breathed.

Petenkofer's method (1860) for determining the amount of carbon dioxide present in the air is an accurate process, but is rather cumbersome and slow. Approximate results can be obtained by means of a simple field apparatus, the Wolpert shaker. A solution of lime water colored with phenolphthalein is placed in the cylinder, the piston inserted and trials made until it is determined what volume of the air is required to destroy the coloration. The gas-volumetric apparatus of Haldane[11, 4] or that of Petterson-Palmquist is much more satisfactory. In these, a measured volume of the air is passed into a solution of caustic potash and the contraction or decrease in volume determined by measurement of the residue. (Figs. 111, 112, and 113.)

SEWER GAS

Sewer gas is characterized by the presence of compounds such as ammonia, hydrogen sulphide, and butyric acid which have unpleasant odors. It is surprisingly free from bacteria, the organisms

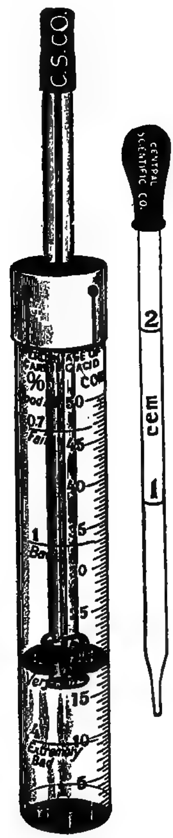

Fig. 111.—The Wolpert shaker for the determination of carbon dioxide in air.

being held in the liquid. At one time it was blamed for causing diseases such as diphtheria, but the general consensus of opinion now is that such is not the case. Nausea and loss of appetite are the effects noticed especially in those who are not accustomed to it.

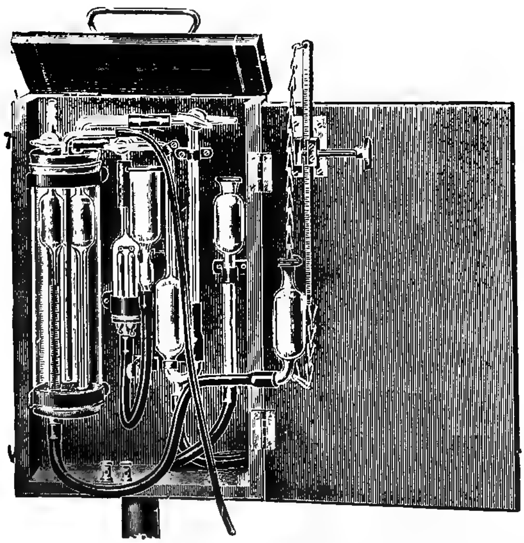

Fig. 112.—Haldane's apparatus for determining carbon dioxide in air.

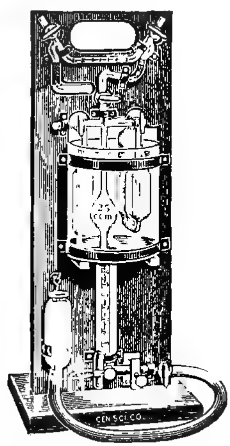

Fig. 113.—The Petterson-Palmquist apparatus for carbon dioxide.

Crowd Poison

There have been many researches carried out to determine the presence or absence of a specific poison given off in the breath of animals. Some of these investigations have been made with man.

The final conclusion is that there is no such poison. Some of the apparent effects may have been due to the conditions of experiment in which carbon dioxide would reach the limit at which asphyxiation would be possible, especially if combined with a very low oxygen content and undesirable physical conditions of temperature and humidity.

It is true that in the air of crowded rooms there are gases not included in the above statements. Complex organic compounds are present in the perspiration. Intestinal gases often contain sulphur compounds and other complex compounds such as skatol and putrescin. If the teeth are not clean and retain food debris which undergoes bacterial action in the mouth, the breath is liable to be contaminated with compounds of objectionable odor. During convalescence from conditions such as empyema, and from catarrhal troubles generally, most unpleasant odors are given off. The general effects of breathing such contaminated air are depression, loss of appetite, and impairment of vigor.

BAROMETRIC PRESSURE

Variations in barometric pressure are accompanied by corresponding alterations in the respiration and circulation. When the pressure is diminished the rates of respiration and of blood circulation are both increased. Noises in the head, dizziness, dullness and sleepiness are commonly observed. If the change in pressure is made suddenly, the resulting effects are shown in weakness, dizziness, and nausea. The physiological reasons for these effects are not free from obscurities although studies in aviation have evolved tests to establish the resistance of the individual to pressure changes which are necessarily encountered in that field. Divers and those who work in caissons must withstand high pressure and be able to adjust themselves readily to the return to normal pressure. When the barometric pressure is increased the rates of respiration and blood circulation are both lowered, this being accompanied by an adjustment of the gas pressure in the blood. The greatest danger arises when the pressure is suddenly decreased. Gradual decompression, usually through a series of controlled chambers is necessary for safety.

These phenomena are not encountered in ordinary rooms. Alterations in pressure such as occur from day to day and hour to hour

have little effect. Low barometric pressure is encountered when high altitudes are reached, for the reason that the barometer measures the pressure of the air above it. We live at the bottom of an ocean of air which becomes less dense as we go to higher levels.

DISTANCE ABOVE SEA LEVEL (Feet)	BAROMETRIC PRESSURE (Inches of Mercury)
0	30
910	29
1850	28
5900	24

The fall in barometric pressure which often precedes a storm is due in part to the displacement of air by water vapor. One liter of dry air at 0° and 760 mm. weighs 1.293 grams; one liter of water vapor calculated to the same conditions weighs 0.80 grams. Consequently, when the atmosphere becomes highly charged with water vapor over an area, the barometric pressure falls.

Barometric pressure may be satisfactorily determined by barometers of the mercury or of the aneroid type. Recording barometers are now available in a reliable form.

TEMPERATURE

Temperature of the air may be determined by mercury thermometers or by those of the bimetallic type. Recording instruments are the most useful because a series of readings is of greater value than casual observations which may not be taken at the proper times. These instruments have been used for some time in control of factory processes which are exacting in temperature control, and are now beginning to make their appearance in large offices, schools, etc. Serious fallacies result when the effects of temperature changes are considered by themselves alone without taking into account the humidity and circulation of the air, still the control of the temperature by means of thermostats can be recommended. Increased efficiency of workers, increased freedom from respiratory diseases, and saving of fuel all result when overheating is avoided.

HUMIDITY

The humidity of the air is quite variable owing to the fact that the area of water exposed is different for different localities. Even

at the same point on the earth's surface, the amount of water vapor taken up depends upon the temperature. The following are saturation figures:

Temp.	grams per cubic meter
0°	4.835
5°	6.761
10°	9.330
20°	17.118
30°	30.039
37°	43.465

The absolute humidity may be determined by collecting the moisture from known volumes of the air. This may be done in the laboratory by passing the air through previously weighed drying tubes charged with a drying agent such as concentrated sulphuric acid, calcium chloride or phosphorus pentoxide. For the practical purposes of ventilation investigations, use is made of the *relative* humidity which may be defined as the percentage of saturation with water vapor.

$$\text{Relative Humidity} = \frac{\text{Amount of water present in a volume of air}}{\text{Amount of water in that volume at saturation}} \times 100$$

Approximate determinations of the relative humidity may be made by means of the wet and dry bulb thermometers mounted side by side. The temperature as indicated by the dry bulb is in ordinary rooms, higher than that of the wet bulb. The reason for this is found in the loss of heat from the thermometer bulb occasioned by the latent heat of vaporization of the water which is vaporized from its surface. Tables have been constructed from which the relative humidity can be readily derived from the thermometer readings. The objection to this form of hygrometer is the lag. This is overcome in a newer instrument known as the sling psychrometer. By means of this device the wet and dry thermometers are whirled for a time and the results obtained are consistent. (Figs 114 and 115.)

Humidity is the great factor in influencing the control of the temperature of the body. The skin with its exceedingly complex system of nerve endings and pores is normally giving off moisture. It is in fact an essential part of the temperature regulat-

Table LXXXIII

Relative Humidity Table.—Pressure=29.0 inches

Reading of Dry Bulb Thermometer	Difference between Dry and Wet Bulbs Relative Humidity																								
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	17.5°	18°	18.5°	19°	19.5°	20°	20.5°	21°
65 degrees....	95	90	85	80	75	70	66	62	57	53	48	44	40	36	32	28	25	23	21	19	17	15	13	12	10
66 "	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33	29	26	24	22	20	18	17	15	13	11
67 "	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	30	27	25	23	21	20	18	16	15	13
68 "	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	31	28	26	24	23	21	19	17	16	14
69 "	95	90	86	81	77	72	68	64	59	55	51	47	44	40	36	32	29	27	25	24	22	20	19	17	15
70 "	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30	28	26	25	23	21	20	18	17
71 "	95	91	86	81	77	73	69	64	60	56	53	49	45	41	38	34	31	29	27	26	24	22	21	19	18
72 "	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32	30	28	27	25	23	22	20	19
73 "	95	91	86	82	78	73	69	65	61	58	54	50	46	43	40	36	33	31	29	28	26	24	23	21	20
74 "	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	32	30	29	27	25	24	22	21
75 "	96	91	87	82	78	74	70	66	63	59	55	51	48	44	41	38	34	33	31	30	28	26	25	23	22
76 "	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35	34	32	30	29	27	26	24	23
77 "	96	91	87	83	79	75	71	67	63	60	56	52	49	46	42	39	36	34	33	31	30	28	27	25	24
78 "	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43	40	37	35	34	32	31	29	28	26	25
79 "	96	91	87	83	79	75	71	68	64	60	57	54	50	47	44	41	37	36	34	33	31	30	29	27	26
80 "	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	37	35	34	32	31	29	28	27
82 "	96	92	88	84	80	76	72	69	65	62	58	55	52	49	46	43	40	......	37	......	34	......	31	......	28
84 "	96	92	88	84	80	77	73	70	66	63	59	56	53	50	47	44	41	......	38	......	35	......	32	......	30
86 "	96	92	88	85	81	77	74	70	67	63	60	57	54	51	48	45	42	......	39	......	37	......	34	......	31
88 "	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43	......	41	......	38	......	35	......	33
90 "	96	92	89	85	81	78	75	71	68	65	62	59	56	53	50	47	44	......	42	......	39	......	37	......	34
92 "	96	92	89	85	82	78	75	72	69	65	62	59	57	54	51	48	45	......	43	......	40	......	38	......	35
94 "	96	93	89	86	82	79	75	72	69	66	63	60	57	54	52	49	46	......	44	......	41	......	39	......	36
96 "	96	93	89	86	82	79	76	73	70	67	64	61	58	55	53	50	47	......	45	......	42	......	40	......	37
98 "	96	93	89	86	83	79	76	73	70	67	64	61	59	56	53	51	48	......	46	......	43	......	41	......	39
100 "	96	93	90	86	83	80	77	74	71	68	65	62	59	57	54	52	49	......	47	......	44	......	42	......	40

Psychrometric Tables, C. F. Marion, U. S. Department of Agriculture.

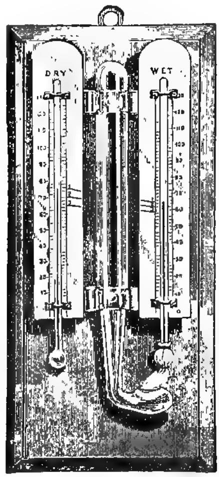

Fig. 114.—Wet and dry bulb thermometers.

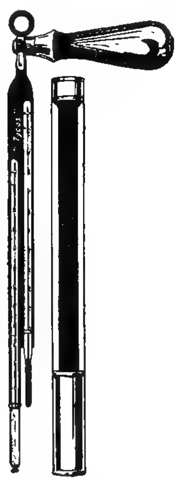

Fig. 115.—Sling psychrometer.

ing devices of the body. It is readily influenced by changes in the environment. High humidity is commonly encountered in crowded rooms. It is estimated that each person gives off (in the breath and perspiration) about 20 grams of water per hour. The effect of this in crowded, badly ventilated rooms is to raise the humidity to a point where evaporation of the water from the surface of the

body is interfered with, the natural cooling device does not function and the net result is discomfort. This may be relieved to some extent by giving the air motion. Extensive studies of these problems by various investigators have shown that the so-called "blanket of discomfort" which is the cause of complaint in crowded rooms is not due to carbon dioxide or to "crowd poison" but to excessive humidity and air stagnation.

Even in outdoor air, heatstroke may be encountered if the humidity and temperature are both high. The effect of high humidity is therefore to give apparent intensification of heat. It likewise intensifies cold. All have felt the bite of cold winds saturated with

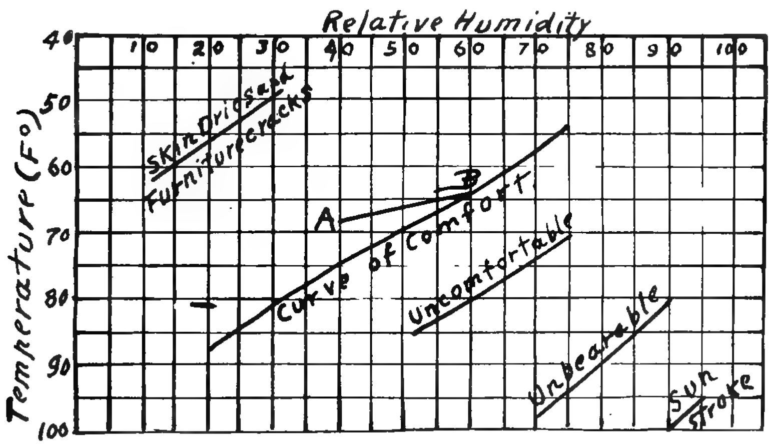

Fig. 116.—The curve of comfort (after Richards). Showing the relation between temperature, relative humidity, and comfort; *AB* is the curve for indoor workers.

moisture. Apparently the moisture is a good conductor of heat and the loss of heat from the body is too great for comfort. The same temperature would be endured much better if the air were drier.

Excessive dryness of the air is commonly experienced in dwellings in the winter months. As seen from the above table, a cubic meter of air at the temperature of melting snow contains about 4.8 grams of water. When brought into a house and heated to 68° F. it requires 17.1 grams before saturation is reached. Unless there is some provision for adding moisture to it, the result is bodily discomfort because of the intensive evaporation of moisture from the

skin. One feels a sense of chill, there is dryness of the lips and conjunctivae. Indeed it has been found that for general comfort both humidity and temperature should be controlled. Fig. 116 gives a concise summary of these various effects.

The Kata thermometer is a newer instrument devised by Hill for the purpose of estimating the probable sense of heat loss which

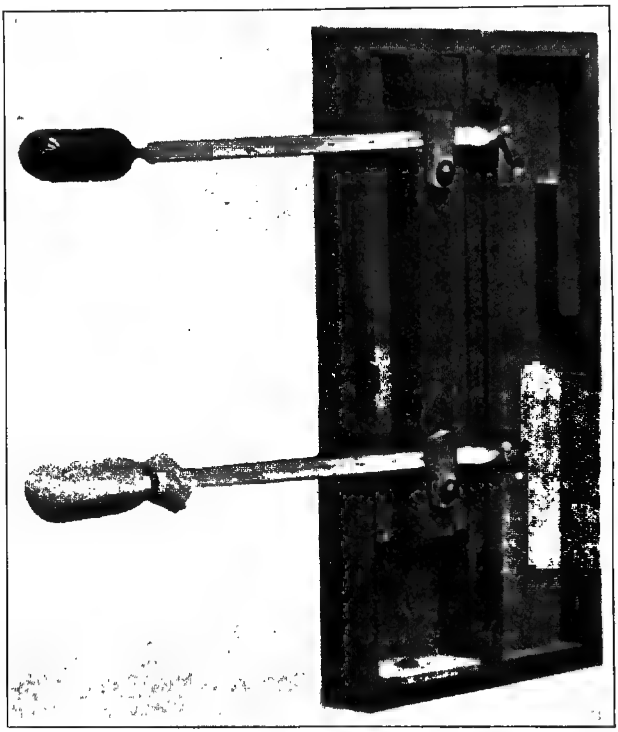

Fig. 117.—The Kata thermometer.

persons will feel when exposed to the air under investigation. It consists essentially of two alcohol thermometers, the bulb of one of which is encased in a finger stall from a Lisle thread glove. A stopwatch is used to measure the time required for the reading of the thermometer with the moist jacketed bulb to drop to a certain level after its temperature has been raised. As it is desired to estimate the cooling power of the air at about 98° F., the interval

100°-105° is used on the Kata scale. (Fig. 117.) Another instrument, the "comfortimeter," designed by Phelps is based on the same principle and is likely to prove of value in this work.[2]

ORGANISMS AND DUST

The living organisms of the air include spores of molds, wild yeasts and bacteria. Street dust commonly contains as many as 50 million bacteria per gram. Indoor dust contains fewer organisms, from three to five million per gram. Tubercle bacilli have been found in dust collected from close proximity to pulmonary cases. They may be carried by heavy winds, or indoors, may be thrown into the air by dry sweeping, careless dusting, beating or shaking of carpets, etc. The organisms discharged in spray from the mouth and nose by coughing and sneezing soon settle. However, such discharges are thought to play an important part in the transmission of diseases such as smallpox, scarlet fever and influenza. The danger of infection from the air is greatest when there is overcrowding or when infected dust is violently agitated. In those persons who breathe through the nose there is a natural protection for the retention of solid particles many of which never reach the bronchi. Table LXXXIV shows in a general way the bacterial condition of the air in various places where excessive amounts of dust are not present.

TABLE LXXXIV

BACTERIA IN AIR

	BACTERIA PER CU. FT.		
	GROWING AT 20°	GROWING AT 37°	ACID FORMING STREPTOCOCCI
Outdoor Country Air	56	30	12
Outdoor City Air	72	32	11
Offices	94	80	22
Schools	96	80	30
Factories	113	63	43

The natural conclusion is that, compared with other sources, the danger of infection from the air is very slight. There are various laboratory methods for the estimation of such organisms in air. In principle they all depend upon passing a known volume of the air through a collecting medium such as sand, sugar or water and plating therefrom.

Dust particles are always present in the air and cannot be entirely avoided. Large amounts of dust are, however, looked upon with suspicion because of the attention which has been drawn to factory hazards such as are encountered in very dusty trades. Metallic particles containing iron are among the most dangerous. Certain siliceous dusts made up of sharp-angled fragments produce pulmonary fibrosis which renders the individual an easy victim for infection with tuberculosis. Carbonaceous dusts, on the other hand, seem to be productive of an increased resistance to tuberculosis. The simplest methods for estimating the number of dust particles in the air by exposing open dishes for a time are crude, but may be

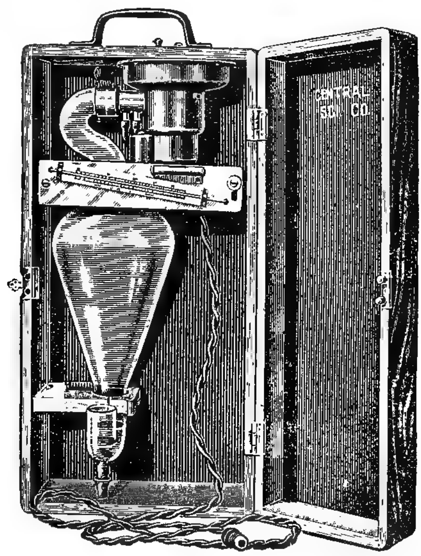

Fig. 118.—The Palmer spray apparatus for the collection of dust from air for examination.

sufficient for some purposes. More elaborate methods are based on the principle of producing cloud effects with moisture in observation chambers.[9] Each dust particle acts as a nucleus about which a droplet may form. As such methods are bound to be more or less empirical, it is advisable to have a standard procedure agreed upon as a working basis by those who are concerned. The American Public Health Association has officially endorsed the Palmer spray apparatus (Fig. 118) in which an electric motor is arranged to draw

a current of air through a chamber so designed that dust particles in the air are held in the water. The volume of air passed is measured by a meter, and the particles counted under the microscope, using a Sedgwick-Rafter cell, a micrometer ocular and a ⅔ inch objective. The apparatus is expensive but is much superior to the older forms using hand pumps and other unstandardized improvisions.

INJURIOUS GASES

Poisonous fumes and gases are encountered in many factories and workshops. The most commonly occurring poisonous metallic fumes are those of lead, arsenic, and zinc. Gases such as hydrogen sulphide, oxides of nitrogen, carbon monoxide, arseniuretted hydrogen, phosphine, aniline, etc., are encountered as hazards in many industries. The recognition, control, and prevention of them are essentially problems for Industrial Hygienists.[6]

Carbon monoxide is rather exceptional in being a poisonous gas to which the majority of persons are more or less exposed. This arises from the fact that it is a common constituent of illuminating gases. The natural gases as a rule contain very little carbon monoxide and only small amounts of it are found in coal gas. It is common gas-house practice to dilute the coal gas with the so-called "water gas" which is made by passing steam through towers containing highly heated coke. By this process a gas mixture is obtained consisting largely of hydrogen and carbon monoxide. At times of coal shortage the content of carbon monoxide in illuminating gas may reach as high as 20 per cent. The action of carbon monoxide as a poison is very well established. Its combination with the hemoglobin of the blood takes place readily, and the effects are shown not only in fatalities which follow the inhalation of large quantities of the gas but also in the anemia which results from the continuous breathing of air contaminated with only small amounts. People should be warned against working near leaking gas fixtures. Flexible tubings should be frequently inspected. There have been many reports of fatalities resulting from this form of poisoning in places where the gas pressure fluctuates sufficiently to extinguish the flame of a stove or gas light burning in a sleeping apartment. The restoration of the gas pressure after the flame has been extinguished is very likely to produce serious results. In some States of the Union there

are limits set to the permissible content of carbon monoxide in illuminating gas, but in the majority of places there are no standards. Another source of carbon monoxide poisoning is from the gases which leak from pipes leading from fires which are not supplied with a quantity of air sufficient for complete combustion.

It will be seen from the above that the problems of ventilation are by no means simple, and are not capable of any one solution which will be universally applicable. There are, however, certain general principles which must be kept in mind. Air space necessary, changes of air required to avoid unpleasant odors, conditioning as regards dust removal, heating humidification or cooling to maintain a suitable temperature, and the maintenance of a proper circulation of air, are all important factors.

AIR SPACE REQUIREMENTS

The air space to be provided per person can be calculated from various formulae but results are found to vary widely. In many instances conditions result which show the difficulty of applying mathematics to the solution of such problems. If we begin by fixing a permissible limit of six to eight parts per 10,000 for the carbon dioxide content of the air, allow for the amount exhaled per person, and also for that given off by gas lights and burners, we conclude that each individual should be supplied with 2000 cubic feet of air per hour, or slightly more than 30 cubic feet per minute. It was long assumed that the air in a room could not be changed more than three times per hour without creating objectionable drafts. With this as a working basis the space per person would be a little over 600 cubic feet. The difficulties in a rigid application of these figures arise from the impossibility of fixing a carbon dioxide standard and from the fact that with modern systems it is quite possible to change the air in a room more than three times per hour. Suggested standards for air space requirement vary all the way from 400 cubic feet per person in schools to 5000 cubic feet per person in hospitals. A more logical basis would take into consideration radiation losses rather than the carbon dioxide content. An adult gives off at least 400 B.T.U. (British Thermal Units) per hour, and if the air is in such condition that this may be accomplished without discomfort, the carbon dioxide content may be greatly in excess of 6 or 8 parts per 10,000 without any serious consequences.

CIRCULATION OF AIR

The circulation of air in rooms has received considerable attention in recent years, especially since Hill's famous experiments on the influence which air circulation exerted upon individuals previously made very uncomfortable by being confined in a limited space in which the temperature and humidity both were increased while the air remained stagnant. Relief immediately followed the circulation of the air, although there was no change made in the carbon dioxide content of the air or in the relative humidity.

In an ordinary room, air currents are often very deceptive. They may be detected by burning touch paper to make a smoke, or by means of thistle down, or by hydrogen-filled balloons. The anemometer (Fig. 119) is a useful instrument for measuring the velocities of air currents, but it is limited to the investigation of rather rapid currents such as are found in ventilating systems in which fans are operated. It is frequently found that air will pass from an inlet to an outlet almost in a direct channel without mixing throughout the room. In many rooms with very high ceilings, with no openings in the upper portion there is no circulation whatever in the upper four or five feet. That constitutes virtually a "dead" space. It is recommended that for schools the classrooms should not have ceilings over twelve feet six inches in height. In studying air currents one should always remember that air is a fluid, and that it is comparatively heavy, one liter of it (measured at 0°) weighing rather more than 1.29 grams. It is therefore quite possible to set

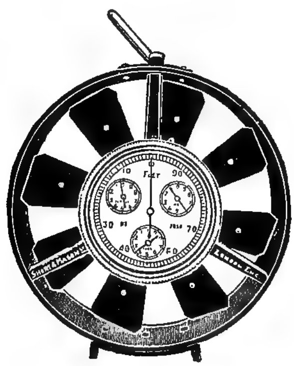

Fig. 119.—Anemometer for the investigation of air currents.

up currents which are quite comparable to the channel currents in a body of water. Further difficulties are encountered when we attempt to calculate the amounts of air admitted to a room by leakage around the windows and doors or through the walls. An ordinary brick wall is porous and may permit the passage of a considerable amount of air. As far as drafts are concerned, it must be admitted that under normal conditions a draft upon the portions of the body accustomed to exposure has a tonic and stimulating effect. This does not apply if the person is overheated, or if the air of the draft is excessively hot or cold. Hill points out[2] the effects produced by having the feet exposed to cold air while the upper portions of the body are in air which is overheated, humid and stagnant. In such circumstances the majority of people show an alteration in the mucous membrane of the nose. It becomes swollen and spongy, with consequent discomfort and lowered resistance to infection. These facts may have more bearing upon ventilation problems as related to health than is generally supposed. It is not unusual to find cold air near the floors not only of dwellings but also of schools and auditoriums.

OVERCROWDING

While much may be done to increase comfort by having the air in gentle circulation, it must not be forgotten that in overcrowded places air currents tend to promote the dissemination of disease-producing bacteria ejected by sneezing and coughing. These would ordinarily settle rapidly since they are specifically heavy, but they are readily carried by air in rapid motion. From the standpoint of transmission of disease, fans in densely crowded places such as railway coaches do not solve the ventilation problems. The only solution is in preventing the overcrowding. Ozone has been exploited as a deodorizer and disinfectant for air. It does not operate satisfactorily in either way. In amounts which would destroy bacteria it is irritating to human beings. It does not destroy odors, merely adds another which is its own.

HUMIDIFYING

While excessive humidity may contribute to discomfort in crowded rooms, on the other hand in the northern climates it is

necessary to humidify the air in dwellings, schools, and office buildings during the winter months if best results are to be obtained. As will be seen from the table on page 582, when air is drawn from the outside at the temperature of melting ice, brought indoors and heated to 65° F., it is relatively dry and tends to take up moisture from all possible sources. The drying effect is shown not only upon the people in the room, but also upon fittings, books, furniture, etc. The difficulty is best met by adding moisture to the air. If a stove is used for heating, a kettle will vaporize sufficient water to supply the deficiency. The hot air furnace is supplied with a vapor pan which should be always kept filled with water. For humidifying the air heated by hot water and steam heating systems, pans

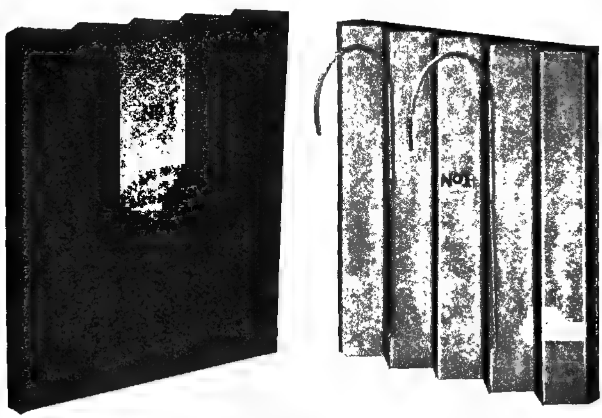

Fig 120.—An air moistener which is made to hang at the back of a radiator.

may be hung at the radiators. (Fig. 120.) As a general rule it is better to vaporize the water at a comparatively high temperature as the tension at low temperature is small and consequently vaporization is much slower.

VENTILATING SYSTEM

Of the larger modern plants, that of the Bell Telephone Company at Boston has been most frequently referred to in this connection. Over 450 persons worked in a building providing 450,000 cubic feet of space. Air was supplied by a plenum system with a capacity of 26,000 cubic feet per minute. The air was heated to about 100° F. in the stack room and moistened to 50 per cent relative humidity.

The water used to humidify this air amounted to 675 gals. per ten hours. There was a marked increase in comfort and efficiency of employees when this system was put into operation and it was noted that there was no complaint from feeling cold or chilly with the thermometer reading three degrees lower than it did formerly when the air was excessively dry.

Such ventilating systems are necessary for the maintenance of satisfactory air conditioning at all times. Much may be accomplished with good window area with devices to deflect incoming air to the upper portions of the room. But there are times when this cannot be made to operate satisfactorily. With a good fan system, however, one is independent of weather conditions outside. Exhaust systems which remove the vitiated air are of value, but a combination of the plenum and the exhaust systems is more flexible and gives better opportunity for filtering out dust, "scrubbing" or washing, humidifying and heating to the proper temperature. In the plenum system air is forced into the rooms which are connected by a distributing system of pipes with a fan. The air escapes from the rooms by outlets such as doors, windows, cracks, and crevices.

For the control of air dustiness in factories and workshops, the exhaust fan is the most useful device yet applied. A great deal may be accomplished by designing apparatus and machinery which will carry on the processes of manufacture without producing dust or allowing it to be scattered into the air. The design of mechanical systems of ventilation offers an extensive field for the engineer, because there is no one universal system which will fit all cases; each problem has features of its own. It must be remembered that there are certain dusty trades, and that while such dusts may involve a health hazard, they cannot be completely eliminated. It has been suggested[10] that permissible limits be worked out for each trade or occupation by actual tests made with the best known dust-removing devices in operation. The aim would be to bring the poorly ventilated factory or workshop up to the level of the best of the same kind. It is only by actual tests of the dustiness of the air at the time a ventilating system is operating that the best estimate of its efficiency can be made.

For indoor conditions, then, we should aim to have a temperature of 65-68° F.; extremes of humidity, both high and low, should be

avoided; the air should have gentle but not excessive motion; offensive odors should not be noticeable, and the air should be free from poisonous fumes and large amounts of dust.

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CHAPTER XXII

INDUSTRIAL HYGIENE

By J. G. Cunningham, M.B., and R. M. Hutton

Industrial hygiene is the science of the health of the industrial worker and is concerned primarily with the human organism as affected by the various conditions of modern industry. At the same time it is impossible narrowly to confine the scope of industrial hygiene within the limits of actual industry, and while its interest is centered on humanity in its working capacity—on the human machine that is—it is imperative to remember that this machine, unlike the nonliving machine, never stops but continues to operate with a different purpose and under different conditions outside the plant. This means that study of the machine must be carried outside the plant and that the aim of those concerned in the promotion of industrial hygiene must be to further conditions that make for health and to prevent conditions that make for ill health in *all* the circumstances of an industrial worker's life—his home life as well as his plant life.

It is here that the *science* of industrial hygiene comes in, since knowledge of the effect of conditions of life on health can only be gained by study of the human body—its senses, functioning, development, growth and capacity—in definite relation to those conditions. Such study, involving investigation into the effect on health of things like sanitation and ventilation, hours and type of work, food and recreation, housing and general home surroundings, is the task of those scientists who are concerned with discovery of the laws of industrial physiology; application of the laws as and when they are discovered is the task of many: of the legislator, of the industrial management as a whole, and, primarily, of the industrial physician.

Industrial hygiene, both the science and the practice, is looked upon as a twentieth century development, since it is only within very recent years that it has been at all generally realized that it is in the laws of physiology that definite criteria should be sought for the ideals of working conditions. The reforms of the nineteenth

century, aiming chiefly at the redress of palpable evils, such, for instance, as the exploitation of young children, arose haphazardly from the benevolence of humane employers who, with certain notable exceptions, were guided by personal feeling and idiosyncrasy both as to selection of the object of redress and as to method. There was little or no scientific investigation into the actual effects of the conditions they guessed to be wrong, and, correlatively, little or no anticipation of what the results of their reforms would be. Thus as late as 1894 there is a characteristic note of surprise in the comment of Sir William Mather on the fact that his experiment in reducing hours of work from 53 to 48 had resulted in decreased lost time and increased cheerfulness and brightness. "We seem," he wrote, "to have been working in harmony with a natural law, instead of against it."

Today, "to work in harmony with the natural law" (that is, of course the law of physiology) is the first premise of all endeavors to promote industrial hygiene and it seems at first sight extraordinary that realization of this principle in its application to industrial health should have been so long delayed. It must be remembered, however, that while in one sense of course "industry" is as old as the world, "industry" as we understand it today, in its proportions, its energy, its world-wide intercommunications, its concentration and specialization, is only as old as the invention of machinery. The problem of health and industry up to 1770 and before the Industrial Revolution, had relatively few distinguishing features from the general health problem which is the subject of medicine as a whole. It is the development of civilization with its inventions, its international competition and its general speeding up of the national pulse which has produced the special and peculiar problems of health in industry and has led to the need of specialized study and treatment. Further, the science of medicine as a whole has made unprecedented advance during the last couple of decades, most notably in the direction of preventive medicine, and, finally, the same progress which has stimulated our modern industry and our modern medical science has also, on the moral side, stimulated our public conscience to the ideal that not only some fortunate members of the community but each member should "live a healthful life at the top of his capacity of body and mind, avoiding or removing external and internal conditions unfavorable to such a

standard, able to work to the highest power, able to rest to the fullest, growing in strength and in *joie de vivre.*"

It has been said that regulation of industrial conditions in accordance with the requirements and capacity of the human organism is primarily the task of the industrial physician. Before dealing in any detail with the different factors of his problem it is necessary to indicate briefly how complex and many sided the whole problem is.

In the first place, of course, it is intimately tied up with industry as a whole, with its main line of development, its sudden changes and advances, its fluctuations, diversions and undercurrents. The industrial physician then should have a general understanding of what industry is, of its object—the best possible production at the lowest possible cost—its organic nature with the consequent reactions in one country to crises in another country, its relationship to international finance and to international politics as a whole, and, finally, following upon this and more specifically, he should have at least a potential appreciation of its many practical problems, whether of commercial ethics, of human relationships, or of trade processes.

In addition, he should have an interest in sociology with an understanding of the conditions and standards of life of the indigenous worker and an appreciation of the problems which may arise from the differing racial and national characteristics of the immigrant worker.

Finally, he should have as wide a knowledge as possible of psychology, both generally, in its relation to physiology, and specifically in its application to industrial management. The problem of placement or job adjustment is from the health standpoint as important as, if not more important than, any in industry. Any progress in the formulation of principles whereby each individual worker may be assigned to the task for which he has natural aptitudes of mind and temperament is a direct contribution to the general problem of health promotion. The science of psychology is making rapid advances at the present time, more especially in the industrial field, and the industrial physician should keep in touch with the current developments and have a knowledge of the practical investigations and experiments which are everywhere being made, most widely in the States but also in England and Europe.

The foregoing indicates to some measure the scope of industrial hygiene. Its extent may be judged from the fact that there are 33,000,000 industrial workers in the United States. All these from the age of entering industry to death come within the range of the industrial physician practicing preventive medicine. At present there are about 900 industrial establishments employing 1500 full-time or part-time physicians. That is, 1 per cent of all the physicians in the United States are engaged in industrial hygiene, medicine, or surgery on a full- or part-time basis.

ENVIRONMENTAL FACTORS

While the influence of environment on health is not restricted to industry, it is there seen in its most poignant form owing to the large numbers of persons involved and the degree of confinement necessitated. Further, there are inevitably particular hazards arising from specific industrial processes. The chief environmental factors affecting industrial health are considered under the following heads:

Accident Prevention

Liability to accident may be mentioned first among the environmental conditions affecting good health, mainly on account of the activity which has centered around the prevention of accidents in recent years. A necessary step in the accomplishment of the results which have been obtained has been a knowledge of the causes of accidents and effective means for prevention. It has been determined that general hygienic conditions, such as good ventilation, have a definite relation to the incidence of accidents, presumably in that these conditions are conducive to good health. Special features, such as intensity of illumination and general cleanliness, which necessitates the disposal of waste, are of importance. While the provision of mechanical devices to safeguard machinery is necessary, this of itself will not prevent accidents. It has been established that the most important factor in accident prevention is the whole-hearted cooperation of the individual workman. It is of special importance that this be recognized in efforts toward sickness prevention.

Sanitation

Ventilation.—Hill's work on ventilation establishes the fact that "successful ventilation depends on the prevention of stagnation of body heat on the one hand, and of uncomfortable chilling of the body on the other." The cooling power of the air is the determining factor and is influenced by air movement, temperature, and humidity. Radiation, convection, and evaporation play a part. The thermometer indicates a *degree* of temperature but is no measure of a rate of change, which is the body stimulant and as such is of first importance.

Hill devised the Katathermometer to determine this rate of change—described by him as follows:

"It consists of a large-bulbed spirit thermometer of standard size and shape, graduated between 100° F. and 95° F. The bulb is heated in hot water in a thermos flask until the meniscus rises into the small top of the bulb. It is then dried, suspended, and the time of cooling from 100° to 95° F. taken with a stopwatch, in seconds. The number of seconds divided into a factor number (approximate to 500 and determined for each instrument) gives the cooling power by convection and radiation exerted on the surface of the 'Kata' at approximately skin temperature in millicalories per square centimeter per second. The operation is repeated with a moist, cotton muslin finger stall on the bulb and the wet 'Kata' cooling power obtained, the cooling power due to evaporation, radiation, and convection. The difference between the two gives the evaporative cooling power."

It has been determined that the dry "Kata" cooling power in an ordinary room for sedentary workers should be 6 and for those at exercise, 7 or 8. The wet "Kata" cooling power should not be less than 18.

The volume of fresh air entering the breathing zone may still be measured by estimating the carbon dioxide in the air, although the actual carbon dioxide content of air in inhabited rooms never reaches a point dangerous to health. The air supply is inversely as the increase of carbon dioxide due to respiration. It may be computed from the following equation:

$$A = \frac{vP}{X - N}$$

v equals the carbon dioxide produced by one person, that is, 0.6 cubic feet per hour.

P is the number of people in the room.

X is the proportion of carbon dioxide per cubic foot in the inside air.

N is the proportion of carbon dioxide per cubic foot in the outside air (.0003).

A is the air supplied to the room in cubic feet per hour.

Here vP is the carbon dioxide produced by the occupants and $X - N$ is the respiratory contamination.

The carbon dioxide content of air may be measured by means of either the Haldane or the Petterson-Palmquist apparatus.

The air movement required will depend on the type of work engaged in, whether sedentary, light, or heavy. For comfort, there are three factors to be considered,—air movement, temperature, and humidity. In some processes high degrees of temperature or of humidity are necessitated, but in these cases comfort may be maintained by varying the other factors involved—humidity or temperature as the case may be, and air movement. For instance, at 65° F. a high humidity has a cooling effect. Beyond 70° F. perspiration commences. High humidity lessens this and so heats the skin still further. Here only increased movement of air of lower humidity will suffice. Where many changes of air are required hourly, the incoming air should be broken up into fine currents to avoid a feeling of draft.

Winslow gives the following instance of the extent to which adequate air change may lessen the incidence of infectious catarrhs: "The installation of a $75 system of ventilation in the operating theatre of a telephone exchange at Cambridge, Massachusetts, was followed by a reduction in winter absences from over 4.5 to 1.9 per cent of the force employed."

Legislation regarding working conditions ordinarily provides that the temperature and humidity shall be such as to insure the workers' comfort, stipulating that in no case shall the temperature be less than 60° F., that ventilation shall be sufficient and adequate, that the incoming air shall be free from filth, and that from 250 to 300 cubic feet shall be available for each individual. The lack of provision for a sufficient volume of fresh air is apparent.

Adequate ventilation is closely associated with the structural condition of the plant involved, and the importance of attention to this and other problems in sanitation, at the time of construction of the plant cannot be overestimated.

Natural Ventilation unassisted is seldom effective in industrial plants. At times the necessary air changes can be effected in small plants with the addition of fans placed in the walls so that fresh air may be drawn in at, or above, the head level, in accordance with Hill's determination that the head should be cool and the feet warm.

Artificial Ventilation is of two different types:

(1) The exhaust system, by which air is drawn from the rooms with fans and a system of piping and openings provided by which fresh air may enter to take its place.

(2) The Plenum system, by which air is drawn into the building, heated in winter and cooled in summer, washed and humidified by passing through water sprays and conveyed to different rooms by a system of piping.

More frequently a combination of these systems is used and this is now considered to be the most satisfactory method.

Lighting

Natural Lateral Lighting is best from a health standpoint. This is frequently difficult to obtain, but can be supplemented to advantage by skylight to give natural lighting in the center of large rooms used for industrial purposes.

Windows should extend nearly to the ceiling but nothing is gained by having them less than two feet from the floor.

A member of the Royal Institute of British Architects has indicated that the width of rooms which may be adequately supplied with natural lateral light may be determined as follows:

Where light is available for one side only, multiply the distance from the floor to the top of window by 1.75; where light is available from both sides, multiply the distance from the floor to the top of the window by 4. This applies provided the walls and ceiling are finished in light colors and kept clean and that no obstruction by adjoining buildings is present. Where this latter exists, prismatic glass is effective.

A common ratio indicates that window space should be to floor space as 5 is to 12.

Blinds rolled from the bottom will lessen the intensity of sunlight close to the window and allow all available daylight to enter the middle of the room.

Artificial Lighting.—General illumination should be suspended so as to be well above the head level and should be provided with enameled iron reflectors. The number and intensity of the lights required will vary for each plant according to its construction and arrangement.

For special work requiring greater intensity of illumination, individual lights, shaded so that the light is reflected to fall on the object worked upon and not on the worker's eyes, should be provided. At present investigations are being made which seem to indicate that the intensity of illumination required varies considerably with the color and reflecting power of the background and that the optimum intensity of illumination is adequately measured by its influence on the time required by the individual to act on the impression received by the retina.

In certain states, notably New Jersey and Pennsylvania, codes of lighting, including intensities of illumination for different parts of the workshop, have been incorporated in the Legislation (see Appendix A).

The following, extracted from the New Jersey code, is valuable for its practical use as a standard in factory inspection:

	Foot-candles at the work: Ordinary practice		Minimum
(a) Roadways and yard thoroughfares	0.05	0.25	0.02
(b) Storage spaces	0.50	1.00	0.25
(c) Stairways, passageways, aisles	0.75	2.00	0.25
(d) Rough manufacturing, such as rough machinery, rough assembling, rough bench work	2.00	4.00	1.25
(e) Rough manufacturing involving closer discrimination of detail	3.00	6.00	2.00
(f) Fine manufacturing, such as fine lathe work, pattern and tool making, light-colored textiles	4.00	8.00	3.00
(g) Special cases of fine work; such as watch making, engraving, drafting, dark-colored textiles	10.00	15.00	5.00
(h) Office work, such as accounting, typewriting, etc.	4.00	8.00	3.00

NOTE: Measurements of illumination to be made at the work with a properly standardized portable photometer.

Sanitary Facilities

The necessity for the provision of sanitary facilities in industrial plants is being more and more recognized. In addition to its obvious use in the general maintenance of health, it has a specific value in the prevention of diseases like oil dermatitis and lead poisoning. This is often only realized after there has been an outbreak of some such sickness and the employer, looking for preventive measures, has been surprised to find that these consisted chiefly in provision of ordinary facilities for personal cleanliness.

Factory codes of regulations for sanitary facilities have been adopted in the Legislation of Great Britain, many of the states of the United States, and some of the provinces of Canada. The following may be taken as the minimum requirements:

(1) **Wash Basins.**—In some instances general provision is made for washrooms supplied with clean towels and soap. For ordinary industrial pursuits there is generally required:

One basin for every 25 workers, male and female separate.

Where work is particularly dusty and dirty, as in foundries, or where it is dangerous to health:

One basin for every five workers, or

Two feet of smooth, impervious trough for every five persons.

Plugs for basins or troughs are insanitary.

(2) **Lavatories.**—Nearly all factory legislation has some provision for lavatories. Where no distinction is made between water closet and urinal, which is an insanitary practice, ordinarily:

One convenience is required for every 25 workers.

Where water closet and urinal are separate:

One urinal to every 25 workers and one water closet to every 25 workers.

At times the proportionate number of facilities is decreased as the number of employees rises above 500.

Adequate arrangements are required for privacy, cleanliness, ventilation, and heating in cold weather.

(3) **Baths.**—The provision of baths or showers is limited to foundries or places with excessive heat, dust, and dirt.

Requirements vary from:

One to every five workers to one for every 50 workers.

(4) **Dressing Rooms.**—Existing legislation commonly requires

provision of dressing rooms for females where a change of clothing is necessary. Provision should be made for drying clothes when the industrial process involves work in wet places, or in a high temperature. Where lockers are provided there should be 1 for each employee, located close to washing facilities, made of steel, and properly ventilated. They should be raised about 4 inches from the floor for cleanliness and should be at least 5 feet in height (inside measurement).

Mere provision of facilities without arranging for effective supervision and securing cooperation of the individuals for whose use they are intended is not adequate.

General Cleanliness

General cleanliness implies neatness and order and, in addition to being a factor in the prevention of disease, is of importance in its influence on the morale of the workers and also contributes to the prevention of accident.

Occupational Disease

While the general conditions of environment in industry and the adjustment of each worker to his particular job are factors in the production of ill health, there are certain specific illnesses which arise directly out of the worker's employment and are known as "occupational, or industrial, diseases." These may be broadly classified by cause as produced by

(1) Dust.
(2) Poisons.
(3) Animal organisms, e.g., anthrax.
(4) Vegetable organisms, e.g., actinomycosis.

(1) *Dusts* may be subdivided into:

(a) Organic, as for example, flax and hemp, which are of minor importance.

(b) Inorganic. The most important of these are those high in silica content. These dusts break up into small, sharp-edged particles. Particles in size from 1 to 10 microns are responsible for the lung fibrosis produced in stone grinders and miners of quartz rock.

The actual determination of the amount of dust in the air which the worker breathes is attended by considerable difficulty. The

Palmer spray apparatus has been recommended by the American Public Health Association. The method of collecting the dust, counting the particles, and the calculation of the number of particles per cubic foot of air is described in the Amercian Journal of Public Health for January, 1916, vi, 54. A tentative standard of 200,000 particles of one-quarter standard unit (.0001 square millimeter) per cubic foot of air may be taken as the maximum amount of dust allowable consistent with health.

The prevention of disease from dust is attempted in two ways:

(a) By keeping the surfaces at which dusts are formed wet with water or oil. Recent investigations indicate that this method may provide a false sense of security, since considerable dust is blown into the air in spite of the moisture.

(b) By provision of exhaust systems whereby a system of pipes connected with suction fan carries off the dust. The amount of suction necessary varies with the type of material dealt with. Efficient operation depends on constant supervision. Legislation, as, for example, in the Wisconsin code, (see Appendix B) indicates in detail the diameter of suction pipe required for certain diameter of wheel used in grinding, buffing, or polishing. A test for suction is made by connecting a U-tube barometer with a suction pipe 12 inches from its connections with the hood. The surest method of determining the effectiveness of exhaust systems is by determination of the dust content of the air at the breathing level.

(2) In England *poisons* have been subdivided as follows by Dr. Legge, His Majesty's Medical Inspector of Factories and Workshops:

(1) Inorganic
(2) Organic

The subdivisions of *Inorganic* poisons are

(a) Non-metallic
- chlorine
- calcium chloride
- hydrochloric acid
- potassium chlorate
- hydrofluoric acid
- carbonic oxide
- phosgene
- carbon dioxide
- cyanogen compounds
- ammonia

nitrous fumes
phosphorus
phosphoretted hydrogen
arsenic compounds
antimony compounds
sulphur dioxide
sulphuric acid
sulphuretted hydrogen
carbon bisulphide
chloride of sulphur

(b) Metallic
chromic acid and chromates
manganese dioxide
sulphate of nickel
mercury
lead

The subdivisions of the *Organic* substances are

(a) The Unsaturated Carbon Compounds
benzine
petroleum
methyl
ethyl
amyl
allyl-alcohol
oxalic acid
formaldehyde
acetaldehyde
acrolein
acetone
methyl-bromide
iodine
nitroglycerine
di-methyl-sulphate
amyl acetate

(b) The Aromatic Series
benzol
nitro and amido derivatives of benzene
toluene and their homologues
dinitrobenzene
trinitrotoluene
anilin
paranitranilin
and their chlorine substitution compounds

Phenol and its nitro derivatives, dinitrophenol and picric acid
chlorine compounds of carbon
ethylene and ethane (such as carbon tetrachloride and tetrachlorethane)
pyridin
naphthalin
benzidin
acridin
turpentine

The most important of these are carbon monoxide, sulphide of hydrogen, lead, mercury, nitrous fumes, and arseniuretted hydrogen.

The concentration at which industrial poisons produce disease varies with the poison and with the individual. For instance, naphtha requires high concentration, while arseniuretted hydrogen may readily prove fatal in small doses.

Notes on the Chief Industrial Poisons

Carbon Monoxide.—Carbon monoxide is a colorless, tasteless gas. In a state of diffusion it is odorless. Burns with a blue flame in the air. Found in coal vapor, illuminating gas, water gas, and producer gas.

Carbon monoxide is found associated with the following processes: tending blast furnaces, coke ovens, smelting furnaces, gas machines, lime and brick kilns; in iron and metal foundries, tin shops and gas purification.

Detection.—Its presence in the air may be determined by means of the iodine pentoxide method of Seidell.

Haldane used birds to detect its presence and the United States Bureau of Mines has determined that a canary will collapse when the concentration of carbon monoxide in the air is as low as .2 per cent.

Carbon monoxide in the air to the extent of .01 per cent is dangerous to human health and should be removed. It is inhaled through the respiratory system and forms a new compound, methemoglobin, in the blood.

Prevention.—Where carbon monoxide is suspected, frequent tests should be made. Where its presence is at all likely, provision should be made for ample ventilation both by natural and artificial means.

Where carbon monoxide is generated, the places involved should be enclosed so as to be gas tight and should be connected with an exhaust system.

Where these provisions are not possible, operating conditions should be such that men only have to remain in them for a short time.

Lead.—Lead is a bluish white, highly lustrous metal. It melts at 325° C. and vaporizes at 650° C. It is found very widely in industry but particularly in the smelting of lead and lead bearing ores, storage battery factories, pottery manufacturing, manufacturing of rubber goods, iron and steel rolling mills, glass manufacturing, printing and publishing and the painting industry. Lead may enter the body by ingestion, as by eating food with lead on the hands, by inhalation, and possibly, by absorption through the skin.

Lead poisoning is still extremely common although preventive measures adopted have considerably reduced its incidence. British factory inspection reports, for the decade 1900 to 1910, indicate that there were 7000 cases of lead poisoning, of which 383 were among painters and plumbers and 200 among printers.

New York State experience in 1909 and 1910 showed that out of 60 deaths from lead poisoning, 45 occurred in the painting industry, 3 in the lead smelting industry ,and 4 in printing establishments.

In New York State from September, 1911, to September, 1912, there were 125 cases of lead poisoning of which 51 were among house painters, 22 among painters in shops, 21 in electrical battery manufacturing plants, and 7 in white lead manufacturing.

Dangerous dose.—Teleky says 1 mgm. of lead ingested daily for several months will produce plumbism and 10 mgms. daily will produce serious symptoms in a few weeks.

Determination of lead in the air.—The amount of lead in the air may be determined in a manner similar to that for other dust determination. Briefly, a measured volume of dusty air is caused by means of an aspirator to pass through a filter previously dried and weighed and capable of arresting dust. The filter is then again dried and weighed, the increase of weight representing the dust separated from the volume of air aspirated. If lead is present, it is then dissolved from the filter and estimated colorimetrically. This method is explained in detail in a publication of the Committee on Standard

Methods for the Examination of Water and Sewage, 2nd Edition, 1912, Laboratory Section, American Public Health Association.

Prevention.—The general directions for the prevention of lead poisoning are briefly given in a leaflet published by the New York State Department of Labor, Bureau of Labor Statistics, and reproduced here as follows:

NEW YORK STATE DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

LEAD POISONING
INFORMATION FOR WORKMEN
AND
DIRECTIONS FOR PREVENTION

All doctors and hospitals are required by the law of 1911 to report all cases of lead poisoning to the Department of Labor. The results of the first year of reporting show:

That lead poisoning is one of the most common of the diseases due to occupation.

That two-thirds of the reported cases of lead poisoning occur among painters.

LEAD POISONING CAN BE PREVENTED

It is preventable partly by the proper ventilation of factories and shops. Hoods and other mechanical means to take away lead dust and fumes are necessary. Respirators for workers exposed to lead dust are very useful and should always be used.

But to large extent lead poisoning may be prevented by the workmen themselves. *Lead is poison to the body.* Those who work with lead must themselves use the greatest care. Among white lead workers and others exposed to lead, the care which the workers take of themselves is of the first importance.

Carefully prepared information for the use of those who handle lead in any of its forms is printed on this card. By following this advice most workers handling lead in any form may escape lead poisoning.

READ THIS ADVICE CAREFULLY. REMEMBER WHAT YOU READ. FOLLOW THE ADVICE GIVEN.

These cards will be sent free, in such numbers as wanted to any who can assist in their useful circulation. They can be furnished in other languages than English. Send request to State Department of Labor, Albany, N. Y.

HOW MEN ARE POISONED BY LEAD

(1) Lead is poison to the body. It enters the body mainly through the nose and mouth. It may be inhaled as dust or in fumes. It may be swallowed with food or saliva (especially if tobacco or gum is put into the mouth with soiled fingers). Or it may sometimes be absorbed through the skin.

(2) When lead gets into the body, it leads among other things to indigestion and lead "colic"; to diseases of the heart, blood vessels and kidneys; or to paralysis of the hands, known as "wrist drop."

(3) Lead acts upon the body slowly and insidiously. Without knowing your danger you may be getting some lead poison into your body every day. If you are working with lead in any one of its many forms, you must therefore use great care so as to protect yourself against it.

(4) On the very first sign of not feeling well, see a doctor or go to a dispensary. Do not wait until you are too sick to work. The earlier you go to a doctor, the easier it will be to cure you if you are being poisoned by lead. BE SURE TO TELL THE DOCTOR ALL ABOUT YOUR OCCUPATION AND ITS DANGERS.

HOW TO PREVENT LEAD POISONING

(1) Always wash before eating and if you work in a factory before leaving the factory.* Remove all dirt from under your finger nails with a brush.

(2) Never eat in the room in which you work.†

(3) Never chew tobacco or gum while working. If you do, the lead dust on your fingers and in the air is sure to be swallowed.

(4) Use overalls when you work. Do not wear your working clothes on the street or at home. They may contain lead and poison you and others.

(5) Respirators are very useful and should always be used when working among lead dust or fumes.

(6) Keep the workroom clean. Do all you can to keep down dust. Do not get lead on your hands and clothes any more than you can possibly help.

(7) Always eat a good breakfast before going to work. Drink plenty of milk. Have at least one good movement of the bowels every day. Constipation is a suggestive symptom of lead poisoning. Avoid the use of intoxicants in any form. Their use weakens the body and makes it harder for your body to overcome the poison of lead.

(8) Keep clean. Wash with warm water, soap, and nail brush. Take at least one full hot bath a week.

Arseniuretted Hydrogen Gas Poisoning.—*Incidence of Poisoning.*—Arseniuretted hydrogen gas poisoning may occur wherever there is any chemical action of acid on metal when either one or both are arseniferous. Traces of hydrogen arsenide may be found in all hydrogen gas used in industry, unless it is produced by electrolysis.

In England arseniuretted hydrogen gas poisoning has been reported from various chemical works, from oil works and from industries such as the manufacture of wall-papers and the bronz-

*In factories the Labor Law requires employers to furnish washing facilities, including hot water and individual towels.

†The Labor Law forbids any worker to take food into any part of a factory, shop or working place where lead is present in "harmful quantities."

ing of art metal. The cases reported in German literature come chiefly from the chemical and metallurgical industry and from the making of balloons and toy balloons.

Description of the Gas.—A colorless extremely offensive gas with the odor of garlic.

Entry.—In the form of gas, through the organs of respiration.

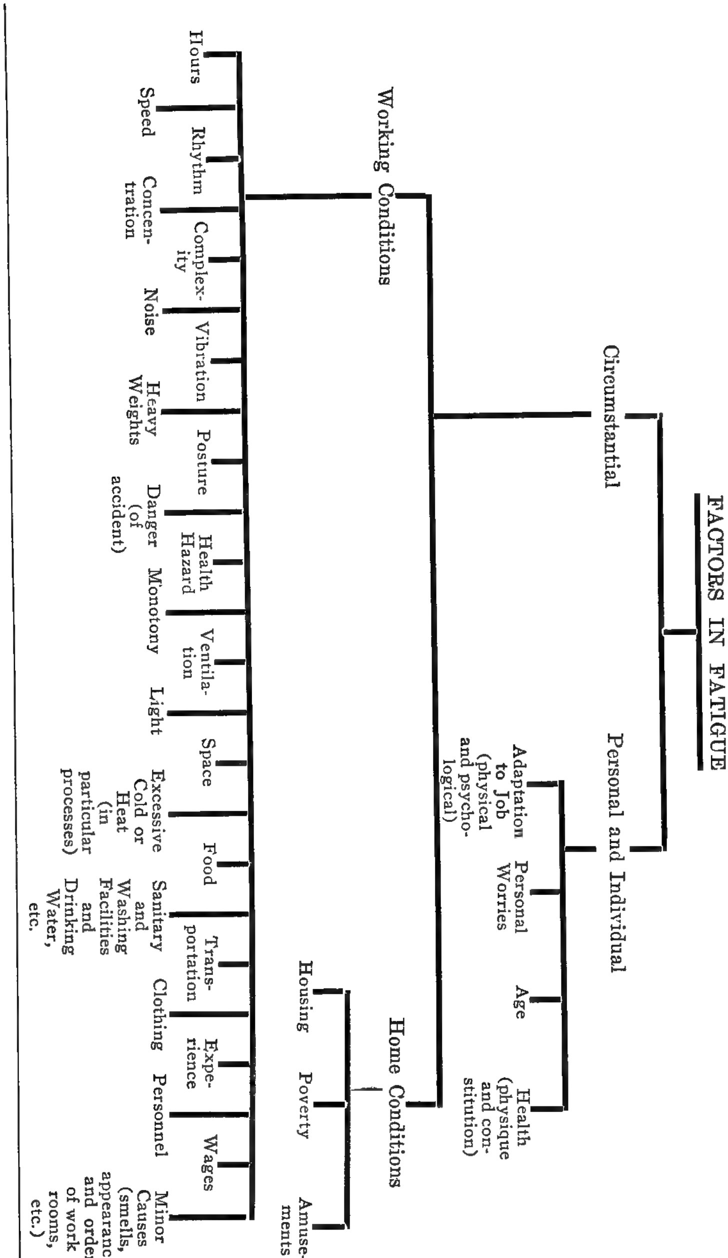
Dangerous Dose.—A German investigator concludes from recent investigations that the fatal dose of hydrogen arsenide for man is about 0.1 to 0.15 gm. Another investigator states that danger begins when the air contains 0.05 parts per thousand and that 0.03 parts per thousand will produce poisoning after several hours.

Detection of Arseniuretted Hydrogen Gas.—According to an article by F. Koelsch in *Zentralbl. f. Gewerbehyg.*, abstracted by Dr. Alice Hamilton in the *Journal of Industrial Hygiene, December, 1920, p. 155,* hydrogen arsenide causes mercuric chloride to turn yellow, thus making it possible to detect small quantities of hydrogen arsenide by means of filter paper wet in mercuric chloride solution.

Preventive Measures.—(1) Where acids and metals are used together, both should be as free from arsenic as possible. (2) Workers should be warned of the danger and instructed how to act in emergency. (3) For any soldering process the use of hydrogen produced electrolytically and procurable in steel cylinders is advisable.

Fatigue

General Definition.—The problem of fatigue in industry is one of the chief problems both of the industrial management, since fatigue does more than any other single factor to reduce efficiency, and of the industrial physician, since fatigue is the greatest predisposing condition for actual disease. In the modern scientific sense in which the word is used fatigue is not merely another name for tiredness, but is the name assigned to the condition in which there is an accumulation within the body of the waste products of activity. Workers who are suffering from industrial fatigue are not simply workers who feel tired—they may or may not do so. They are workers whose capacity for work is steadily, day by day, diminishing.


FACTORS IN FATIGUE
Circumstantial
Personal and Individual
Working Conditions
Home Conditions
Adaptation to Job (physical and psychological)
Personal Worries
Age
Health (physique and constitution)
Housing
Poverty
Amusements
Hours
Speed
Rhythm
Concentration
Complexity
Noise
Vibration
Heavy Weights
Posture
Danger (of accident)
Health Hazard
Monotony
Ventilation
Light
Space
Excessive Cold or Heat (in particular processes)
Food
Sanitary and Washing Facilities and Drinking Water, etc.
Transportation
Clothing
Experience
Personnel
Wages
Minor Causes (smells, appearance and order of work rooms, etc.)

Factors in the Causation of Fatigue.—The causes of fatigue are obviously complex. They are made up of many very divergent factors and are peculiarly subject to modification by personal characteristics and idiosyncrasies. If for any individual suffering from fatigue it is desired to find the cause of his condition, it is necessary to weigh all the factors of his life in considerable detail and over a considerable period of time. The accompanying chart gives an idea of the general scope and complexity of the problem, which centering in physiology and psychology, reaches out also far into the field of economics and sociology.

Detection of Fatigue.—At the present stage of knowledge fatigue is normally very difficult of diagnosis since, in the first place, symptoms of tiredness and the like may not appear for some time after the condition has actually set in, and, in the second, both the effects of fatigue—a diminished capacity for work, and inefficiency in general—and the symptoms may very easily be confused with inherent psychological traits due to heredity, and insusceptible to practical preventive measures. Considerable advance is being made in practical methods of detecting fatigue in the plant. This subject is dealt with in a most valuable production of Columbia University, "Use of Factory Statistics in the Investigation of Industrial Fatigue" by Sargant P. Florence of the United States Public Health Service, and it is sufficient here to refer to the chief factors involved in this indirect system of ascertaining fatigue by measuring efficiency. These are amount of power consumed, amount of out-put, amount of spoiled work, amount of accidents, amount of lost time and amount of lateness. A study of statistics in any one plant with a view to discovering these facts with further consideration of them in relation to time of day and to external occurrences will do much to indicate in a general way the degree to which fatigue is reducing the efficiency of the workers.

Welfare

Welfare in industry has been defined as "anything for the comfort and improvement, intellectual and social, of employees outside wages paid, not a necessity in industry, nor required by law." This is the definition adopted by the United States health authorities and is understood to include such activities as provision for recreation, rest rooms, systems of loans and profit sharing, and industrial can-

teens. With the exception of canteens, these things may be said to influence health only indirectly. The United States dictionary definition of welfare is "prosperity and happiness"; the British dictionary definition is "a satisfactory state of health, prosperity, and happiness." This difference in point of view is of interest in that the Welfare Department of the British Ministry of Munitions, established under the Home Office in 1916, was charged with attention to cloak rooms, mess rooms, washing facilities, first aid, and drinking water in industrial plants. In 1918 this supervision was extended to the provision of suitable seats, rest rooms, and clothing for workers. Throughout, moral supervision has played a prominent part. Provision has been made for special training for welfare supervisors and by 1920 there were employed in industry in Great Britain about one thousand women welfare supervisors and four hundred men welfare supervisors for boys. It should be observed that welfare activities in America, which are many and varied, and in some instances very extensive, are ordinarily conducted directly or indirectly through the employment department of the plant.

Industrial *lunch rooms* from a strictly health standpoint may be considered the most important health activity in welfare. Large numbers of these have been established. The cafeteria system is favored. It is felt that in the majority of instances the full benefit to be derived from the establishment of these lunch rooms is not obtained, because they are only used for the convenience of employees in either providing hot liquids to supplement a lunch carried to work, a light lunch with the idea that the employee may get dinner at home at night, or a full-course meal. The opportunity for indicating to workers at the same time the importance of selection of kinds of food giving the greatest energy value and the proper combination of foods to constitute a meal giving balanced diet is largely lost. Such information carried to their homes would assist in removing the indictment that the cause of much malnutrition is not so much that the money is not spent for food, but that the wrong types of food are chosen. In addition, lunch room facilities encourage the worker to leave the workroom at lunch hour, providing a change and making it possible to ventilate the workroom more thoroughly, and, where such substances as lead are used, assist in preventing the contamination of food.

Legislation in a few instances requires the provision of a lunch

room in cases where employees are exposed to dangerous substances, or where females are employed. The importance of this provision has been much more generally recognized by employers since recent war experience.

Rest rooms, which are most important where women are employed, should provide absolute quiet, preferably under constant supervision.

The Man at His Work

Granted satisfactory environment, consideration must be given to the worker as an individual, that is, to the employee-at-his-work. "Industrial birth," the phrase coined by Collis, refers to the entering of children into industry with the consequent complete change in environment and in discipline. Even for the child who enters in good health, the ordinary difficulties of adjustment to new conditions are great, as is evidenced by investigations which have been conducted in different parts of America. Thus, a recent study in Cincinnati of children entering industry showed that one-third changed their job within three months and one-sixth within one month.

Recognition of the importance of fitness for industrial life is indicated in the factory Legislation of Great Britain and the United States by the requirement of work, or employment, certificates for children entering industry.

In general, in Great Britain children may not enter industry under fourteen years of age (see Appendix C). Those from fourteen to sixteen years of age ("young persons," as they are technically called) require certificates signed by the factory inspector of the district in which they will work, containing:

(1) Statement of age as determined from birth certificate.

(2) Statement that the required educational standard has been attained.

(3) Statement by the certifying surgeon or factory physician that the "young person" is not incapacitated by bodily disease or infirmity from following the employment proposed for the full time allowed by law.

The certifying surgeon is employed by the Government and paid a fee for each examination. His area is limited so that he may, and should, know the industrial condition which the "young person" is

entering. He may use his discretion as to whether he grant the certificate outright, grant it subject to certain restrictions as to the nature of the employment or contingent on the completion of prescribed treatment, or refuse it altogether. Further safeguards are set up for certain processes, as for example, boys tending furnaces at night must be sixteen years of age and up to eighteen years of age must submit to physical examination every six months.

The United States requirements differ for the various states. All save one have some form of employment certificate, containing some or all of the following items:

(1) Statement of age as obtained from birth certificate. Most states make fourteen years the minimum age at which a child may be employed in industry during school periods. In these states, therefore, a child under fourteen may be employed in industry during school vacations and, in some instances, after school hours as well.

(2) Statement that the required educational standard has been attained.

(3) Physician's certificate of physical fitness. The physician is ordinarily the prospective employee's choice.

In eighteen out of forty-nine states, this certificate of physical fitness is required. In ten states the certificate is optional with the issuing officer, who is generally a factory inspector. In twenty states there is no provision for physical examination.

As a result of a statistical study by the Cleveland Hospital Council, of employment certificates of the State of Ohio as they refer to Cleveland, in 1920, a "suggested content of Ohio law re-health certificate for child applying for work certificate" was made. This is as follows:

Section 7764-1 (4) Health Certificate. A certificate from the school physician, or if there be none, from the board of health, and if there be no board of health within the school district in question, from a licensed physician appointed by the board of education, showing after a thorough medical examination that the child is physically fit to be employed at the specific occupation for which the child makes application for a permit, such occupation to be one not prohibited by law for a child under 18 years of age.

Periodical examination of children who have been granted one health certificate shall be provided for by limiting the period of time for which certificates

may be issued to two periods of six months each and one period of one year successively. A thorough medical examination showing the child to be physically fit for the employment in which he is to engage or is engaged shall be necessary in every case, before a certificate may be issued. Certificates may be granted for shorter periods of time than six months or one year, successively, if the physical condition of the child warrants more frequent examination, or if the child is allowed to work while receiving medical treatment for correction of remediable physical defects.

A new certificate shall be required upon every change of employment.

An adequate force of qualified physicians and others shall be provided for the work of examination and follow-up which may be necessary.

(Pledge of Employer) (1) A pledge or promise signed by the employer or by an authorized manager or superintendent, specifying the exact nature of the work which the child is required or permitted to do, the number of hours per day during which the child is to be regularly employed, and the name and address of the employer, in which pledge or promise the employer agrees to employ the child in accordance with the provisions of this act, and to return to the superintendent of schools or to the person authorized by him to issue such certificates, the age, schooling and health certificate of the child within two days from the date of the child's withdrawal or dismissal from the employer, giving the reasons for such withdrawal or dismissal.

In order that prospective employees may be assisted in adjustment to the type of work for which they are best fitted, knowledge is required of, first, the physical and mental condition of the applicant, involving physical and mental examination, and, second, a knowledge of the requirements of the prospective work. While some assistance may be rendered adults in advice as to the type of work they may or may not undertake, the impracticability of changing occupation, at least for skilled adult workers, limits the opportunity in this direction. Hope lies in applying the principles of preventive medicine to children entering industry. This should commence before the child has decided to leave school in order that he may have some understanding of the requirements of industry, the importance of health in relation to it, and may be saved the time so frequently taken in wandering from job to job in an attempt at self-adjustment.

The committee appointed by the United States Children's Bureau to formulate standards for the use of physicians in examining children entering employment and children at work reported tentatively as follows:

Summary of Standards of Normal Development and Physical Fitness for Working Children

(Tentative report of the committee appointed by the U. S. Bureau to formulate standards for the use of physicians in examining children entering employment and children at work.)

A. General Recommendations

1. Age Minimum for Entrance into Industry.

Should be not less than sixteen years. It is important to protect a child from the physical and nervous strains of industry because of his general instability during the pubescent period.

2. Physical Minimum for Entrance into Industry.

No child under 18 years should be permitted to go to work who is not normally developed for his age, of sound health, and physically fit for the work at which he is to be employed.

3. Physical Examinations for Children Entering Industry.

A thorough medical examination for entrance into industry should be required and must show that a child is physically fit for industry. Before the examination is made the child must bring a promise of employment from his prospective employer stating the specific occupation in which he is to be employed.

4. Re-examinations for Children Changing Occupations.

With each change of employer another examination should be made before the child is again permitted to work, likewise when a child is transferred in the same place to work differing in its physical demands and hazards from that for which a permit is issued.

5. Periodical Re-examinations for All Working Children.

Yearly medical examinations should be required of all children at work up to the age of 18 years, or more frequently if judged desirable. These examinations shall take place either in the certificate issuing office or in the place where the child is employed.

6. Need of study by local administrative and medical officers of occupations in which children are employed and of their effect upon health.

Occupations employing children should be especially studied by the examining physician, who should also be required to familiarize himself with conditions of employment and the various health hazards of industry.

7. Need of authoritative scientific investigation.

Considerable further study of the effects of different kinds of work upon the physique of the adolescent child is necessary, and especially with reference to:

- (a) Comparison of the rate of growth of children employed in different occupations with that of children not in industry.
- (b) Comparison of morbidity among children employed in different occupations with that of children not in industry.
- (c) Comparison of mortality among children employed in different occupations with that of children not in industry.

(d) Fatigue in children employed in different occupations and industries.

(e) Effect of employment in specific occupations at different stages of physiological development upon the growth and health of (1) normal children, and (2) children with certain physical defects.

(f) Effect of employment in specific occupations upon the special functions and organs of adolescent girls and young women.

(g) Types of work desirable for: (1) children with some mental defect, and (2) children who are suffering from some physical handicap.

Considerable material for these studies could be obtained from public school medical records and records of examinations made for work certificates. All such records should be standardized so as to be statistically comparable.

8. Certain tentative minimum standards obtainable from results of scientific research already available.

Although further study is necessary, there are sufficient data already on hand to justify the recommendation now of certain tentative minimum standards, which will materially safeguard the welfare of children entering industry while still immature.

B. Minimum Standards of Physical Fitness for Children Entering and Working in Industry

1. Standards of normal development.

(a) Certificates should be refused to children who do not come up to the following minimum standards of height and weight for specified ages, based on the most reliable present-day experience.

Age	Weight (in clothing)	Height
14	80 lbs.	58 inches
15	85 lbs.	58 inches
16	90 lbs.	59 inches

Exceptions may be made if other circumstances in the child's case, such as racial characteristics, warrant it.

(b) Certificates should be refused to children who do not show certain unmistakable signs of adolescence.

2. Standards of health and physical fitness for specific employment.

(a) Certificates should be refused permanently to all children who have certain specified defects. All such children should be referred to the appropriate agency for whatever assistance may be necessary.

(b) Certificates should be refused to all children pending correction of all serious remediable defects. Such children should be referred to the appropriate medical agency for the necessary medical treatment.

(c) All children who, for any reason, show a tendency to weakness or disease of any organ should be excluded from occupations which tend to aggravate that tendency.

C. Points To Be Covered and Methods To Be Employed In Physical Examinations.

1. Items for Inquiry.

(a) First examination should include a record of sex, race and nationality, age, intended employer (name and address), intended occupation and industry, school grade completed, family history of father, mother, brothers and sisters, previous illness and physical examination. The physical examination should include the following:

Height	Maturity	Nasopharynx
Weight	Skin	Glands
Physical condition	Eyes	Chest, heart, lungs
Nutrition	Ears	Abdomen
Anemia	Mouth	Nervous system

Summary of defects, as correctable and noncorrectable. Certificate should be (a) recommended after first examination, or (b) refused, either permanently or temporarily, pending correction of specified defect, or (c) recommended after re-examination (that is, after correction of defect).

(b) In re-examinations the same points should be covered as in the first examination, and any changes noted in detail.

2. Record card and instructions for use of examining physician.

The use of a uniform record card is recommended in order that uniformity may be obtained in administration and in statistical analysis. Such a record form is included in the report of the committee. (These standards in full may be obtained from the Federal Children's Bureau, Washington, D. C., upon application.)

While as has been stated, the child offers the best opportunity for the application of the principles of preventive medicine, the problem of the adult in relation to his job is also the subject of investigation.

Dr. E. G. Martin (See Spaeth's article in the *Journal of Industrial Hygiene*) has developed a spring balance for measuring muscle strength in an attempt to determine physical minima for workers doing heavy manual work, calculated to give information to supplement that obtained on complete physical examination. Eight important muscle groups are tested, and the number of pounds registered on the balance by these eight groups added together. The result, multiplied by a constant, given as 6.67, is taken to indicate total body strength.

Spaeth states that a more constant figure for heavy work is given by dividing the total strength by body weight.

Effort has been made to determine more accurately physiological

capacity. On exercise, for instance walking up-stairs, pulse rate and blood pressure change. A normal, strong individual moving from the reclining to standing position has a rise in blood pressure of about ten millimeters mercury. Individuals in poor health from wasting disease, dissipation, etc., with like exercise, tend to show a fall in blood pressure, with an increase in pulse rate. Based on these findings, Crampton has devised a table for estimating percentage of physiological capacity by the response in blood pressure and pulse rate to exercise.

With reference to children, the relation between height, weight, age, and vital capacity (the maximum air expired) affords additional evidence on which to base physiological capacity.

Industrial Medical Service

To provide the necessary supervision to look after conditions of environment and personal health, employers in increasing numbers are establishing medical service within the plant and are finding it worth while for many reasons, among others because "it pays."

Dr. Harry McCord, Director of the Department of Medicine and Public Health, University of Cincinnati, believes that any plant employing 500 or more workers, and many plants employing even 250 or 300 workers, will profit by the full-time service of a qualified industrial physician and by the maintenance of a health service department. This latter he thinks as important as any other non-producing department, such as the auditing or purchasing departments. Certainly many employers with less than 500 workers have demonstrated the value of such service to their own satisfaction.

Organization of an Industrial Medical Service.—I. PRELIMINARY DECISIONS TO BE MADE. The importance of an early decision in matters of general policy is apparent:

(1) The chain of responsibility: This varies considerably in practice. Medical service may be subservient to employment service, but this practice sometimes leads to the suspicion that rejections are attributable to the medical findings alone. It may be responsible to a personnel manager in charge of an industrial relations department, including employment, recreation, and other welfare activities. Success under these circumstances depends largely on the viewpoint of the personnel manager.

Direct responsibility to the manager of the plant in which the medical work is carried on affords the best opportunity for effective service.

(2) Extent of medical service to be provided: Where employers in rural communities institute medical service on account of lack of community medical facilities, they frequently find it desirable to provide for all forms of treatment as well as prevention. Where community facilities are at all adequate, the tendency of many firms with experience in industrial medical work seems to be to leave problems of treatment other than first aid to the community, often assisting it directly or indirectly in this work, but concentrating the efforts of the plant medical service on the work of prevention of sickness and accident and active promotion of health. Even where the medical service is limited to prevention work, provision is commonly made for assistance to employees and their families stricken with illness and unable to cope with their misfortunes.

If more than first aid treatment is to be provided, it must be decided:

(a) Whether employees will be treated for all illness and accident, or only for that part arising out of or in the course of employment. Workmen's Compensation Acts now generally in force provide for the latter in one form or another in any case.

(b) Whether employees only or their families also will be treated. This depends entirely on local conditions.

(c) As to how far attention will be directed to conditions outside the plant affecting the health and efficiency of workers. For example, will the industrial nurse visit absentees from work to determine existing factors influencing health, concerning which she may be of assistance to the employee; or will a lunch room be provided for those who live too far from work to be able to go home at the noon hour?

Frequently it is possible to establish industrial medical service only in a very small way, it being necessary to demonstrate the value of such service as time passes, but a general statement of policy to commence with will assist a medical director enormously and make for more effective organization.

II. Appointment of an Industrial Physician.—(1) *Qualifications.* These have been defined by Dr. Carey McCord as follows:

"(a) He must come to know that an industry is maintained solely to produce, and that the doctor cannot make the plant over into a hospital.

(b) He must have a knowledge, above all, of industrial hygiene, of physical working conditions, heating, lighting, fumes and dust, ventilation, locker rooms, wash rooms, rest rooms, cafeterias, toilet facilities, drinking water, etc.

(c) He must have a fundamental knowledge of industrial relations, employment methods, race problems, mutual benefits, pensions, insurance, liability.

(d) He must have a practical knowledge of hours of work in relation to fatigue and output, shift systems, rest periods, absenteeism, and turnover.

(e) He must be familiar with systems of industrial training—apprentice system, vestibule schools, etc.

(f) He must know that his job is to keep the worker on the job by maintaining such condition in the worker and the worker's surrounding environment that his health will be kept intact.

(g) Last of all, the industrial physician must be a 'human being,' knowing the hearts of these people as well as their hurts."

(2) *Duties:*

1. Physical examination of employees.
   (a) Initial.
   (b) Periodic.

This examination should, according to Dr. H. E. Mock, include the following as a minimum:

"(1) History of patient on regular blank.
   (a) Personal and family history.
   (b) Home conditions and financial conditions.
(2) Temperature, pulse, height, and weight. (These can be obtained by nurse.)
(3) General inspection—color, nutrition, any deformities or congenital malformations, gait, etc.
(4) Inspection of mouth, teeth, throat.
(5) Inspection of eyes—Snellen's test.
(6) Inspection and palpation of neck.
(7) Thorough examination of bare chest.
   (a) Lungs.
   (b) Heart.
(8) Examination of abdomen, genitalia, and extremities in men.
   (a) Hernias.
   (b) Venereal disease.
   (c) Varicosities or flat-foot.

Where history of case indicates some abdominal or other trouble in the female employee, the services of the doctor for a further and more thorough examination, in the presence of the nurse, or the next day when the mother can come with patient, are offered. If refused, refer to the family physician.

(9) A routine urinalysis in all cases—albumin, sugar, and microscopic.

(10) Blood pressure and blood examinations in all cases where history and examination show they are indicated.

(11) Other laboratory tests such as bacteriological examinations, stomach analysis, Wassermanns, x-ray examinations, etc., should be provided when needed, either at the plant office or at an outside hospital.

(12) Examination of the teeth of employees by a dentist who recommends treatment when needed, is a valuable adjunct.

(13) Examination of eyes by a specialist is indicated in all cases of defective vision found at routine examination.''*

2. Supervision of treatment.
3. Frequent inspection of men at their work.
4. Frequent investigation of working conditions.
5. Follow-up of patients sent to hospital and home for treatment.
6. Supervision of medical records and statistics.
7. Consultation with any others responsible for plant welfare as to conditions (home and personal) having effect on health.

III. The Dispensary.—The establishment of medical headquarters—the dispensary—should receive thought and care. Selby's survey of industrial medicine services showed a great variety of dispensaries in operation. He considers that the practice of industrial medicine is still too young to allow of the standardization of a "given dispensary in a given plant in a given industry." Many present the minimum required by Workmen's Compensation Acts. From these are all types in size and equipment to the most elaborate, depending on the size of the plant and the attitude of the management. Certain essentials may be indicated:

(1) *Location:* The dispensary should be centrally located, easily accessible from all parts of the plant, as free from noise and dirt as possible, and situated so as to make good lighting easy.

(2) *Plan:* *Waiting room* should be light and airy, provided with comfortable seats with accommodation for only a few at a time.

Dressing room: In a large plant separate dressing rooms should be provided for men and women; in a small plant arrangements can be made for attendance at different hours except in case of emergency. The dressing room should be the most accessible of all parts of the dispensary, since, at present at any rate, it is the room in most frequent use; should open directly off the waiting

*For further notes on physical examination and suggested forms for recording results of examination see Appendix D.

room, and where possible, exit should be provided by some means other than through the waiting room. Equipment should include dressing table, chairs for patient and attendant, a waste receptacle, foot and arm rests, and stationary wash bowl.

Physician's office and examining room may be combined in smaller plants. Dressing cubicles provided with hooks should open off this room.

Equipment should consist of desk, chairs, examining table, medicine cabinet, wash bowl, diagnostic instruments, and may have a small laboratory.

Record room: Provision for record keeping may be made in the dressing room. Essential office equipment, including a filing cabinet, are required.

IV. NURSES.—The majority of plants establishing medical service have commenced with the employment of a nurse. Workmen's Compensation requirements may have been partially responsible for this, and her duties have not ordinarily, at least to commence with, exceeded the rendering of first aid in the case of industrial accident. The industrial nurse's opportunity reaches far beyond this. In addition to the service performed by any nurse in bringing the scientific knowledge of the physician into close relation with the individual and personal needs of the patient, the industrial nurse has further and similar opportunity in the way of bringing employer and employee into closer touch.

Following upon preliminary education and hospital training, time spent in general public health nursing will give her an insight into the social conditions of the people she is in a position to help, an idea of sanitary inspection, antituberculosis work, prenatal and baby welfare, and school medical work. She should have some knowledge of industrial diseases and be able to distinguish between good and bad working conditions.

Her routine duties will consist in:

(1) The rendering of first-aid to the injured.

(2) The care of cases for dressing under supervision of the plant physician.

(3) The education of employees in the importance of early attention to minor accidents and illnesses, together with general instruction in personal hygiene.

(4) The establishment of contacts through the dispensary with employees whom she is able to assist by advice and direction.

(5) The visiting of employees at their homes, both to determine the cause of the absence and ascertain whether there is need for further assistance, and to form some opinion as to when the worker may return for duty.

(6) In the absence of adequate clerical staff, the keeping of records of sickness and accident, indicating time lost, kinds of illness, departments concerned, results of home visits, and any external factors adverse to health.

(7) Cooperation with community health agencies in the improvement of conditions outside industry which militate against the health of the worker and his family.

For suggested forms for use of an industrial nurse see Appendix E.

V. Dentist.—Some provision for dental service is necessary if the health of workers is to be properly guarded at all points. Experience has more than justified expenditures in this direction.

Ordinarily this service at least provides advice regarding dental repair which should be undertaken.

VI. Records.—Any estimate of the effectiveness of medical service in industry is impossible without adequate records of sickness and accident, treatment administered, and steps taken to prevent recurrence. There is required for this:

(1) Individual record cards (See Appendix F) of all employees disabled by sickness or accident. Upon these should be recorded the amount of lost time, kind of sickness causing it, exact kind of work in which the individual is engaged, and other factors which may have an influence in determining the cause of sickness such as nationality, age, sex, previous employment. A card containing the essential information is incorporated in the appendix.

(2) A form for the monthly compilation of information indicated on the cards of patients, correlating the amount of lost time with predominating types of illness by department serves as a starting point from which to determine preventable causes of sickness or accident within the industry. Such a record is essential both to direct future efforts and to afford a means of assessing progress made. A sample form is included in Appendix G.

(3) Reasons for quitting or being discharged. Very often

the primary motive in the establishment of industrial medical service has been the reduction of labor turnover. Labor turnover is the percentage of the personnel of a given industrial establishment which is replaced in a given unit of time. A labor turnover of 100 per cent means that in a factory in which 100 persons are employed, *100 new workers* are engaged during 12 months. Labor turnover in the United States has been found to be as low as 30 per cent and as high as 176 per cent. In England, according to Collis the volume of labor turnover is very large. An idea of the meaning of this is conveyed by Collis when he writes, "there are some 8,000,000 workers in our factories and shops (in England and Wales). Take labor turnover at 100 per cent, and the cost to employers of replacement at the low figure of £2 per head. We arrive at a total of £16,000,000 (about $75,000,000). The cost to the workers is not less than an equal amount. Hence in factories and workshops alone, without considering mines, railways, transport shipping, shop assistants, agriculture or clerks, industry bears an annual burden (in the United Kingdom) of over £30,000,000 (about $140,000,000) due to labor turnover." In the United States the estimated loss is said to run from $35,000,000 to $50,000,000 annually from this cause.

From the point of view of the industrial physician the importance of detailed records of labor turnover is the light they throw on sickness as a contributing cause.

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CHAPTER XXIII

DEMOGRAPHY AND VITAL STATISTICS

Demography (*demos,* people, and *grapho* I write) is the statistical study of human life. It is essentially the statistical study of vital, human facts. Demography is complementary to hygiene, and if neglected, much that is of practical importance in the development of preventive medicine, public health and hygiene would be impossible. Demography includes the subjects of genealogy, human eugenics, the registration and study of births, marriages and deaths, and their causes (vital statistics), biometrics, etc.

Vital statistics can be obtained only if there is preliminary registration of vital facts such as birth, marriages and deaths. While enumerations of people, that is, a census, for purposes of taxation, war levies, etc., were first made centuries before the Christian Era, the real origin of medical, if not of vital, statistics dates back to 1662 when John Graunt of London published his book "Natural and Political Observations upon the Bills of Mortality." From 1538, when an order was issued by Thomas Cromwell, Vical General, under Henry VIII stipulating that every "parson, vicare or curate, within this diocese shall from every churche kepe one boke or registere wherein ye shall write the day and yere of every weddyng, christenyng and burying made within yor parishe for yore tyme;" parish records of births, marriages and deaths were available in England. Graunt was the first to study these recorded facts. Since statistics are facts expressed by figures, vital statistics are simply vital facts so expressed and they had their real beginning at the time mentioned. Graunt apparently was the first to demonstrate the high rate of mortality in early life and also the contrast between urban and rural rates of mortality.

After Graunt the next pioneer in this field was William Farr, who was born in England in 1807 and who was appointed "Compiler of Abstracts" in the Registrar General's Office in London in 1839. The subject of vital statistics as we know and appreciate it today, owes much of its development to the great work of Farr.

For the practitioner of preventive medicine, as well as for the public health worker, vital statistics are very important if not essential. In organized public health work they are as necessary as is a bookkeeping system in any commercial undertaking. By means of the census the enumeration of all persons in a given community is undertaken, the important facts in regard to them ascertained, and the population data so obtained provides the basis for any system of records subsequently initiated.

Just as a low incident rate of certain communicable diseases and a low infant mortality rate are indices of the state of civilization of a community, so too are the registration of vital facts, and the elaboration of vital statistics indications of enlightenment and intelligence of the people of any community.

Physicians are by law usually required to take an active part in the registration of vital facts, such as births and deaths and by virtue of their professional training and qualifications are usually the only persons permitted to complete certain forms necessary for the registration of these events.

Perhaps the most important vital records are those of births and deaths. From these, and from the classified lists of causes of death, and their arrangement according to age-periods, most valuable and important information is made available. It is necessary at the outset to appreciate, however, that vital statistics or sickness (morbidity) statistics are of value only when they are reasonably complete. In many instances their completion depends upon the physician, therefore he should know what is required of him as a legally qualified physician, in connection with birth and with death notification or registration and should also do what is possible to educate those among his patients who are unaware or careless of their community responsibilities with respect to the registration of either births or deaths.

What are the objects in view in requiring the registration of vital facts? The taking of the census, notification and registration of births and of deaths according to age periods are all of paramount importance to any country. The excess of births over deaths and of immigration over emigration reveals the increase in a country's most valuable asset, men, women and children. In this way the physical growth or decay of a nation is disclosed, the influence on health and well-being of the application of hygienic and sanitary

measures, is made evident and it also shows what potential gains are possible, and what preventable deaths are not prevented. Then too, the movement of population is indicated by these vital records. Through access to the vital statistics of any country, the study of events in great numbers is made possible.

From the individual standpoint the registration of certain facts such as those of births is a most serious matter to those whose births are not registered. Many rights and privileges may be denied those of whom there is no record of birth.

Birth registration by the parents or guardians and notice of birth made by the physician are among the most important things that are done in the interest of any child. Such notice and registration are usually required by law. In the majority of the provinces the physician is given twenty-four or forty-eight hours after the birth of the child in which to give this notice. Such notices may be given by mail, and are sent to the division registrar of the municipality in which the child was born, which officer is usually the municipal clerk. This notifies him that a birth has occurred at a certain address and enables him to be expectant of registration. The parent or guardian is also required to complete a form registering the personal particulars of the birth, and is allowed thirty days in which to file such registration. Better results in registration of births would be obtained if the time limit for registration by the parents was seven to ten days. The child, because these things are done, is later able, if necessary, to prove:

1. His age for school purposes.
2. His age for employment purposes.
3. His right to any inheritance.
4. Citizenship rights, to vote or hold public office, etc.
5. To marry.
6. Age for insurance purposes.
7. Military or other national reasons.
8. Eligibility to enter certain fields of competitive athletics. Similarly the registration of the birth of a child giving the names of the father and the mother, and the time and place of birth is of service to the state for the purposes of:

1. Identification of an individual.
2. Proving time and place of birth.
3. The census—enumeration of population, etc.

Two forms of standard birth certificates are given in Tables LXXXV and LXXXVI. Table LXXXV is that of the United States Public Health Service; Tables LXXXVI and LXXXVII are both parts of Form 3 required in the nine Canadian Provinces, all of which have uniform birth registration. In the collection of vital statistics, the notification of a single event such as a birth or death is made by physician, nurse, parent or guardian to a local (usually municipal) authority, clerk or registrar, who subsequently makes returns to a state or provincial authority. In Great Britain, and many parts of the British Empire the central authority whether federal or provincial is known as the Registrar-General and the local authority as the registrar. In the United States the federal authority is vested in the Census Bureau and the state and municipal authority usually in a state or municipal division of vital statistics in the corresponding department of health. This Bureau, too, is responsible for the organized enumeration of the population, that is the Census. In the Dominion of Canada, nearly all Provinces have a Registrar-General but the work in this branch of the Provincial Government is closely coordinated with that of the corresponding Provincial Health Department. The Province of New Brunswick which has a Provincial Health Department presided over by a Minister of Health and holding a portfolio in the Provincial Government, has a division of vital statistics in the Health Department.

The registration of both the live births and still-births is required in all communities where an attempt is made to record vital facts. A child which is not alive at the moment of birth is stillborn. Still-births are also registered as deaths but they are not estimated or included in the totals of live-births or deaths.

The registration of births, except in certain older countries is very incomplete. In Great Britain it is nearly complete; in the Birth Registration Area of the United States the number of births registered is believed to be about 90 per cent or more of all births. In some local municipalities all births are registered, in others it is much less complete. In the Province of Ontario it is estimated that 90 per cent of all births are registered, in certain other provinces this estimate may be too low or too high. Physicians, public health nurses, social workers and all those whose work makes it

TABLE LXXXV

PLACE OF BIRTH

County of ....

Township of ....
or
Village of ....
or
City of ....

Department of Commerce,
Bureau of the Census,
Standard Certificate of Birth.

State of ....

Registered No. ....

No. .... St........ Ward....

Full name of child.......................... (If child is not already named, make supplemental report, as directed.)

Sex of child	Twin, triplet or other?	Number in order of birth	Legitimate?	Date of birth ....
	(To be answered only in event of plural births)			(Mth.) (Day) (Yr.)

FATHER.	MOTHER.
Full name	Full maiden name ....
Residence	Residence ....
Color.............. Age at last Birthday........ (Yrs.)	Color............ Age at last Birthday............ (Yrs.)
Birthplace	Birthplace ....
Occupation	Occupation ....
Number of children born to this mother, including present birth.......	Number of children of this mother now living ....

CERTIFICATE OF ATTENDING PHYSICIAN OR MIDWIFE:

I hereby certify that I attended the birth of this child, who was.............
.... at ....*M*
(Born alive or stillborn)

(Where there was no attending physician or midwife, then the father, householder, etc., should make this return.) A stillborn child is one that neither breathes nor shows other evidence of life after birth.

Signature......................
....
(Physician or Midwife)

Given name added from a supplemental report

Address...............................

...................., 19

.... Filed............19 ....
(Registrar) (Registrar)

Standard Birth Certificate issued by the Public Health Service.

(Instructions on certain points may be printed on the back. Size of certificate, 6½ x 7½ inches)

MARGIN RESERVED FOR BINDING.

WRITE PLAINLY WITH UNFADING INK—THIS IS A PERMANENT RECORD.

N. B. In case of more than one child at a birth, a SEPARATE SHEET RETURN must be made for each, and the number of each, in order of birth, stated.

possible, should do all in their power by educational means, to arouse interest in birth notification or registration and all should be familiar with the legal requirements in this respect in their own state or province. The completeness of birth registration in any locality can be approximately ascertained in several ways. In the case of deaths of infants, the receipt of a death certificate and burial permit is necessary before interment can be made. This makes it possible by taking the death certificate and searching the records of births to ascertain whether the birth of the infant was registered, also by searching Church records for baptismal records, by checking birth notices in newspapers, etc. By a vigorous campaign of education it is possible to stimulate and vastly improve, as a rule, birth registration in a given community.

When birth registrations are made they are carefully recorded. For statistical purposes the facts contained in the registrations are tabulated, being classified according to race, color, nationality, age of parents, legitimacy, etc. Such facts after being published in reports or other official documents may be studied, and by means of this compilation, comparison of birth rates may be made, one country or community with another.

The crude birth rate is stated as the number of live births per 1000 population of any country or community. A comparison can be made only when such is based upon the common unit; the population is usually taken as the unit. Specific birth rates may be obtained for special purposes, for example, by comparing number of live births with number of women of child-bearing age or the number of married women or the number of births of illegitimate children, etc., in the communities. As has been pointed out, the population is determined by means of an enumeration, the census, which is taken in nearly all countries once in every ten years. In the United States it was first taken in 1790 and it has been taken every ten years since that time. In Great Britain the census has been taken every ten years since 1801. In the Dominion of Canada the first census was taken in 1867, and 1871, and every ten years since. (In certain Provinces every five years also.) To arrive at an estimate of the population in the intercensal years two methods are used. The first, or arithmetical method, is that used by the Bureau of the Census in the United States and also in

TABLE LXXXVI

Form 3

PROVINCE OF ONTARIO

PHYSICIAN'S NOTICE OF BIRTH

To the Division Registrar of..

Municipality or Town of........................County of.................

I beg to notify you of the following Birth in accordance with the Vital Statistics Act, Sec. 14.

Date of Birth.......................... Sex...............................

Where Born ....
(If in City or Town, give street and house number)

Name of Father...

Name of Mother...

Address of Parents...................... Twin, Triplet, Illegitimate, or Stillborn......................

Signature of Physician...

Address.............................. Date...........................

NOTE: The physician or nurse is requested to leave the attached card, (see Table LXXXVII) with the parents or guardians and to inform them as to registration and the name and address of the Division Registrar with whom the birth *must* be *registered* by the *parent* or *other persons responsible within 30 days.*

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the Canadian provinces. In this method it is assumed that any increase or decrease in population noted between the two most recent census enumerations occurred in equal amounts in each intercensal year and continues to do so until the next censal year.

A town with a population of 10,000, in June, 1900, and 12,000 in April, 1910, gained 2,000 in population in nine years, $10\frac{1}{2}$ months. The total increase would be 2,000, and the annual increase

$$\frac{12{,}000 - 10{,}000}{9\,\frac{21}{24}} \quad \left(2{,}000 \times \frac{24}{237}\right)$$

would be 203.

The estimation of population by the arithmetical method is comparable to the calculation of simple interest while the geometrical method is analogous to the determination of compound interest. This latter method takes into account the natural increase in births over deaths resulting from the increase in the number of persons

TABLE LXXXVII

Section	Entries
Place of Birth	**Certificate of Registration of Birth** (By Parent or Guardian) Form 4. — **Reg. No.** .... For use Reg. County — Municipality Street and Number .... (If in hospital, give name instead of street)
Name of Child	Surname .... Give names in full .... Sex | Twin or Triplet | Was Child born alive?
	Legitimate .... Answer Yes or No — Date of Birth ....19.. (Month) (Day) (Year)
Father	Full Name .... Usual Residence .... Racial Origin .... | Age last birthday......... Birthplace .... Trade or Profession .... Kind of Industry of Business in which employed ....
Mother	Full Maiden Name .... Usual Residence .... Racial Origin .... | Age last birthday......... Birthplace .... Number of children including this one — Living | Dead | Stillborn
	Occupation, if other than household duties ....
Informant	Name .... Address ....
	Name of Physician in attendance .... Date of Return ....
Division Registrar	Name .... Address ....

RACIAL ORIGIN will be described by stating to what people, race, or tongue the parents belong, whether English, Irish, Scotch, French, Galician, German, etc. The terms ''American'' or ''Canadian'' *must* not be used as they express citizenship but not a race or people.

of marriageable age and the increase in the marriage rate and the consequent increase in the number of births.

By the geometrical method the estimated population is arrived at in the following way:

P—population—at most recent census.
P′—population at next most recent census.
r—the annual increase per unit of population.

$$\text{Population in } 1911 = P\,(1+r)$$
$$\text{“ “ } 1912 = P\,(1+r)^2$$
$$\text{“ “ } 1913 = P\,(1+r)^3$$
$$\text{“ “ } 1920\ (P') = P\,(1+r)^{10}$$

$$\sqrt[10]{\frac{P'}{P}} = 1+r \text{ and } r = \sqrt[10]{\frac{P'}{P}} - 1$$

(After Trask.)

For England and Wales this geometrical method is used in estimating the population in intercensal years.

The census should, theoretically, be taken at the middle of the year, on June 30. For various reasons, however, it is frequently taken during some other spring or summer month.

Marriage registrations are chiefly of interest from the sociological and economic standpoint. Registration of these is required by law and marriages can as a rule be performed only after the contracting parties have received a license or after the publication of banns. Marriage rates are most commonly expressed as the number of marriages per 1,000 of population. For purposes of comparison the more exact method would be to express the number per 1,000 persons of marriageable age and condition (single or divorced) in the community. Marriage statistics are usually of less significance from the public health aspect than are those relating to births and deaths.

One very important duty in connection with vital records is laid by the State upon the duly qualified physician and that is the completion of the medical certificate of death. The standard certificate of death approved by the Bureau of the Census, of the United States and by the United States Public Health Service as well as that used in the various Canadian Provinces is as shown in Tables LXXXVIII and LXXXIX. It is exceedingly important in this connection that the cause of death, as accurately as possible, both primary and secondary be stated in the form.

TABLE LXXXVIII

Form 5 No. ....

PROVINCE OF ONTARIO

Medical Certificate of Death

County ....
Municipality ....
Street and Number ....
(If in hospital or institution, give name instead of street and number)
Name of Deceased ....
Date of Death ....
I hereby certify that I attended deceased from ....
.... to ....
That I saw h.... alive on the date stated above at ....m
The Cause of Death was as follows:—
Primary ....
.... (duration) .... yrs. .... mos. .... days ....
Secondary ....
.... (duration) .... yrs. .... mos. .... days ....
Where was disease contracted if not at place of death? ....
....
Did an operation precede death? ....
Date of operation ....
Was there an autopsy ....
.... M. D.
Address ....
Date ....

State the disease causing death, or in death from violent causes, state (1) Means and Nature of Injury; and (2) whether Accidental, Suicidal or Homicidal.

THE FOREGOING CERTIFICATE WAS

Filed at .... hrs. .... day .... month

....

Division Registrar.

Notice:—The physician is requested to leave the attached card with relatives or friends of deceased with instruction as to registration and the name and address of the Division Registrar with whom the death MUST be registered FORTHWITH.

In order to establish some uniformity in the assigned cause of death there has been compiled, as a result of various conferences of experts, an international classification and list of causes of death. Every physician should be possessed of a copy of this. By application to state or provincial officers or to the Director of the Bureau of the Census copies may be obtained. The most recent revision of

TABLE LXXXIX

Department of Commerce,
Bureau of the Census.

STANDARD CERTIFICATE OF DEATH

1. PLACE OF DEATH

County ....State .... Registered No.........

Township ....or Village .... or

City ....No. .... St. .... Ward ....
(If death occurred in a hospital or institution, give its Name instead of Street and Number.)

2. Full Name ....

a) Residence No. ....St. .... Ward ....
(Usual place of abode)
Length of residence in city, or town, where death occurred yrs. mos. ds.
How long in U. S. if of foreign birth? yrs. mos. ds.

PERSONAL AND STATISTICAL PARTICULARS	MEDICAL CERTIFICATE OF DEATH
3. Sex — 4. Color or Race — 5. Single, Married Widowed or Divorced (Write the word)	16. Date of Death (month, day and year)......19..
5A. If married, widowed, or divorced Husband of (or) Wife of	17. I HEREBY CERTIFY, That I attended deceased from .... 19 ..., to .... 19... that I saw h.... alive on ...., 19... and that the death occurred on the date stated above, at ....m.
6. Date of Birth (month, day, year.)	

7. Age yrs. mos. **days** If less than 1 day, hrs. or mins.

8. Occupation of Deceased
(a) Trade, profession, or particular kind of work ....
(b) General nature of industry, business, or establishment in which employed (or employer)
(c) Name of Employer..............................
9. Birthplace (city or town)
(State or country) ....

Parents
10. Name of Father ....
11. Birthplace of Father (city or town)
(State or country) ....
12. Maiden Name of Mother ....
13. Birthplace of Mother (city or town)
(State or country) ....

14. Informant ....
(Address)

15. Filed .... 19 ....
Registrar

The CAUSE OF DEATH was as follows:
....
....
.... (duration) ...... yrs. ...... mos......
CONTRIBUTORY ....
(secondary)
.... (duration) ..... yrs. .... mos. ....ds.

18. Where was the disease contracted
if not at place of death? ....
Did an operation precede death? ....Date of......
Was there an autopsy? ....
What test confirmed diagnosis? ....
(signed) .... M.D.
(Address)

State the Disease Causing Death, or in Deaths from Violent Causes State (1) Means and Nature of Injury, and (2) Whether Accidental, Suicidal, or Homicidal.

19. Place of Burial, Cremation or Removal
Date of Burial ....19...

20. Undertaker Address

N. B. WRITE PLAINLY, USING UNFADING INK — THIS IS A PERMANENT RECORD. Every item of information should be carefully supplied. AGE should be stated EXACTLY. PHYSICIANS should STATE CAUSE OF DEATH in plain terms, so that it may be properly classified. Exact statement of occupation is very important.

the list was completed in October, 1920, in an international conference held in Paris.

Death certificates completed by physicians, are sent by the local registrars to the Registrar-General or the Division of Vital Statistics of the State or Provincial Health Department. The returns of deaths in any community are much more complete than are those of births. This is due to the fact that interment is usually impossible without a permit, and such a permit can be obtained only if a death certificate made out in proper form has been completed by the physician. Death rates when compiled are also expressed in terms of the number per 1,000 of population. Such rates (births or deaths) are sometimes designated birth and death ratios.

The death rates per 1,000 of population are what are called "crude" rates. They are based on an estimated population (except in censal years) as of July 1, and are not corrected or adjusted in any way. Without such adjustments or corrections comparisons of rates may have very little value.

To make valid comparisons it is essential to know the number of persons in different age groups, of different races, color or nationality; of the two sexes, the marital condition, occupation, etc. When such facts are known and corrected rates based on adjustments made for differences in age, sex, race or nationality, marital conditions, economic status and occupation; they are then known as specific death rates. Even when all these corrections have been made there still remains one of the most important possible sources of error and that is the statement of the cause of death. Trask has analyzed certain communications dealing with this feature of the subject and strongly emphasizes the fact that the accuracy of mortality statistics is necessarily dependent entirely upon the reliability of death certificates. Thus the value of such statistical material depends in large part upon the care with which the physician carries out his duty in the matter of assigning the proper cause of death. Deaths from specific causes such as typhoid fever, tuberculosis, etc., are usually expressed in terms of the number of deaths from the given cause, per 100,000 of population.

Death rates which are of great importance from a sociological, legal and economic standpoint are of the greatest possible value from a public health standpoint and both crude and corrected rates should be available in every community, so that the progress of

efforts made to promote health and lessen deaths from preventable causes may be seen at a glance.

In connection with the registration and tabulation of deaths those in the first year of life are especially significant. Deaths of infants under one year of age constitute what is known as infant mortality. This is expressed in terms of the number of deaths of infants under one year of age per 1,000 living births. There is perhaps no more important and significant statistical information relating to the vital records of any community than the infant mortality rate. The problems of infant mortality are dealt with in detail elsewhere in this volume.

In addition to statistics relating to births, marriages and deaths, there are those relating to the incidence of various diseases. These are known as morbidity statistics. They are as a rule very difficult to obtain and are everywhere very inadequate. Except in the case of the communicable diseases no effort is made as a rule to notify or tabulate the number of cases of sickness due to different causes. Even the number of reported cases of the communicable diseases is generally believed to be very much less than the number which actually occurs. The list of notifiable diseases of which records are kept, is given in Chapter XII.

There is hardly any need at the present time more pressing from a community health standpoint than accurate and complete morbidity or sickness statistics. A first step in this direction would be taken if every physician would keep records, however simple, of all cases seen by him. Every practitioner of preventive medicine should most certainly regard this as essential.

The rate of maternal deaths in any community is most accurately expressed in terms of the number per 1,000 living births and not in terms of any unit of population.

To compare death rates it is convenient to have available a standard table showing age distribution, etc. For this purpose the so-called "standard million," which shows the age distribution of the population of England and Wales in 1901, is available and is shown in Table XC. This shows the number of persons in the various age groups and of both sexes.

The following extract of the Vital Statistics Act of Ontario (similar legislation exists in all the other Canadian Provinces) in-

TABLE XC

ENGLAND AND WALES STANDARD MILLION OF 1901

AGE-GROUP (1)	MALES (2)	FEMALES (3)	PERSONS (4)
0- 5	57,039	57,223	114,262
5- 9	53,462	53,747	107,209
10-14	51,370	51,365	102,735
15-19	49,420	50,376	99,796
20-24	45,273	50,673	95,946
25-34	76,425	85,154	161,579
35-44	59,394	63,455	122,849
45-54	42,924	46,298	89,222
55-64	27,913	31,828	59,741
65-74	14,691	18,389	33,080
75-	5,632	7,949	13,581

(From Whipple)

dicates the necessary provision which should be made by law for the collection, tabulation and publication of vital statistics data:

PRELIMINARY

2. In this Act— Interpretation.

(a) ''Cemetery'' shall mean any plot of ground in which bodies of deceased persons are interred; "Cemetery"

(b) ''House'' shall include a part of a house and tenement, building, room or dwelling place; "House"

(c) ''Inspector'' shall mean the Inspector of Vital Statistics or his deputy or other person authorized to act; "Inspector"

(d) ''Municipality'' shall not include a county; "Municipality"

(e) ''Nurse'' shall mean that person who attends at the birth of a child, but shall not mean the attending physician; "Nurse"

(f) ''Occupier'' shall include the governor, keeper, warden or superintendent of a goal, prison, penitentiary, lunatic asylum, poor asylum, hospital, industrial home, and house of refuge, and of a public or private charitable institution; "Occupier"

(g) ''Prescribed form'' shall mean the form prepared by the Registrar-General and approved by the Lieutenant-Governor in Council; "Prescribed form"

(h) ''Registrar-General'' shall mean that member of the Executive Council who for the time being is charged with the administration of this Act; "Registrar-General"

(i) ''Undertaker'' shall mean any person who engages in the burial of the body of a deceased person; "Undertaker"

(j) ''Sub-Registrar'' shall mean any person appointed under section 37 of this Act to carry out the provisions of subsection 2 of that section.

3. This Act shall apply to lands reserved for the Indians which for the purposes hereof shall be deemed territory not within a municipality. R.S.O., 1914, c. 49, s. 3.

Application to Indian Reserves.

4. The Lieutenant-Governor in Council may appoint an Inspector of Vital Statistics whose duty it shall be to inspect the registration offices and examine the schedules prepared under this Act to see that the entries and registrations are made and completed in a proper manner and in legible handwriting. R.S.O., 1914, c. 49, s. 4.

Inspector, appointment and duties of.

5. The Registrar-General shall annually collate, publish and distribute for the use of the Legislature a full report of the births, marriages and deaths of the preceding year, giving such details, statistics and information as the Lieutenant-Governor in Council may deem necessary. R.S.O., 1914, c. 49, s. 5.

Annual report of Registrar-General.

6. The Lieutenant-Governor in Council may make such regulations as he may deem necessary for the purpose of obtaining the information required by this Act. R.S.O., 1914, c. 49, s. 6.

Regulations.

7. (1) Any person shall be entitled at all reasonable hours on payment of the prescribed fee and on signing an application in the prescribed form, to have search made of the record of a birth, marriage or death kept in the office of the Registrar-General for any one county or district for not more than three years.

Searching records with Registrar-General.

(2) The Registrar-General shall, when requested, give a certificate of the details of any birth, marriage or death of which there is a record in his office on payment of the prescribed fee.

Certificate of Registration.

(3) The certificate shall be *prima facie* evidence in any court, or in any proceeding before a Justice of the Peace, of the facts certified to be recorded.

Effect as evidence.

(4) The fees to be paid for searches and certificates shall be prescribed by the Lieutenant-Governor in Council. R.S.O., 1914, c. 49, s. 7.

Fees for searches and certificates.

8. The Registrar-General shall cause such schedules and forms to be prepared as may be approved by the Lieutenant-Governor in Council in order to obtain correct statistical information, and he shall distribute them to the Division Registrars, and the cost of and incidental thereto and of the distribution thereof shall be paid out of the Consolidated Revenue Fund. R.S.O., 1914, c. 49, s. 8.

Forms.

9. (1) The Registrar-General shall prepare and issue such detailed instructions as may be required to procure the uniform observance of the provisions of this Act and the maintenance of a perfect system of registration; and no forms shall be used other than those supplied by the Registrar-General.

Instructions.

(2) The Registrar-General shall examine the forms received monthly from the division registrars, and if any such are incomplete or unsatisfactory he shall require such further information to be supplied as may be necessary to make the record complete and satisfactory.

Examination of forms.

10. Every physician, clergyman, nurse, undertaker or other person having knowledge of the facts respecting any birth, marriage or death shall supply personally, or by mail, or through the Division Registrar, such information as the Registrar-General may require, by filling up forms provided by the Registrar-General, or by adding such particulars as may be required upon an original certificate, but no certificate of birth or death after its acceptance for registration by a Division Registrar, nor any other record made in pursuance of this Act, shall be altered or changed in any respect except by amendments properly dated, signed and witnessed.

Duty as to supplying information to Registrar-General.

11. The Registrar-General shall arrange, bind and permanently preserve the forms after the same have been received from the division registrars in a systematic manner, and shall prepare and maintain an index of births, marriages and deaths.

Arrangement and preservation of records.

12. (1) Any cemetery company or association, or any church or historical society or association, or any corporation or individual in possession of any record of births, marriages or deaths which may be of value in establishing the genealogy of any resident in Ontario, may file such record or a duly authenticated transcript thereof with the Registrar-General without charge.

Records which may be filed with Registrar-General.

(2) It shall be the duty of the Registrar-General to preserve such record or transcript and to make an index thereof, and such record and index shall be open to inspection by the public, subject to such conditions as the Registrar-General may prescribe.

How to be dealt with.

REGISTRATION DIVISIONS.

13. (1) All territory within Ontario shall be a part of some registration division.

Registration divisions.

(2) Every municipality shall be a registration division.

Municipalities to be.

(3 Territory not within a municipality may be attached to any existing registration division, or set apart as a registration division, by the Lieutenant-Governor in Council. R.S.O., 1914, c. 49, s. 9.

Unorganized territory.

14. Where a registration division is formed of territory not within a municipality the Lieutenant-Governor in Council may appoint a division registrar therefor and may make such regulations as he may deem necessary to secure a correct record of the births, marriages and deaths occurring therein. R.S.O., 1914, c. 49, s. 10.

Registrars in unorganized territory.

OFFICE AND DUTIES OF DIVISION REGISTRAR

15. (1) The clerk of every municipality shall be the division registrar of the same.

Registrars in municipalities.

(2) The Registrar-General shall supply to every division registrar schelules in the prescribed form upon which the division registrar shall enter the details of every birth, marriage and death registered in his office.

Schedules for division registrars.

(3) The division registrar and every sub-registrar shall make every schedule in duplicate and on or before the 7th day of each month he shall transmit to the Registrar-General one duplicate of each schedule down to and including the last day of the month next preceding, and the other duplicate schedule shall be kept by the Division registrar on file in his office, and he shall also, on or before the seventh day in each month, transmit to the Registrar-General the original returns of every birth, marriage and death made to him during the month next preceding, and if no birth, marriage or death has been registered in any month he shall, on or before the seventh day of the following month, report the fact to the Registrar-General on the prescribed form. Schedules of returns how and when to be made up.

(4) The duplicate schedule shall be bound up or otherwise arranged from time to time by the division registrar in such manner as may be prescribed. Arrangement.

(5) It shall be the duty of the division registrar to keep the schedules, forms and documents received by him in a place of safety, and he shall use all available means to obtain the necessary information for the purpose of completing the records required to be made by him. R.S.O., 1914, c. 49, s. 11, (1)-(5). Custody.

16. If the division registrar has reason to believe that a birth, marriage or death has taken place within his division which has not been registered he shall inform the proper person of his duty to register the same, and on the failure of such person to make the registration within seven days the division registrar shall forthwith supply the Registrar-General with such information as he possesses with regard to the matter. R.S.O., 1914, c. 49, s. 11, (6). Action by division registrar on non-registration.

17. (1) A division registrar, upon application therefor, and on payment of a fee of twenty-five cents shall give a certificate in the prescribed form as to any registration filed with him during the preceding three months, but shall not give any certificate other than such as is authorized by this section or in any other than the prescribed form. Certificate of division registrar. Certificate of registration.

(2) The division registrar shall be entitled to the fee for the certificate for his own use. R.S.O., 1914, c. 49, s. 12. Fee

18. (1) If within one year from the registration of a birth, marriage or death any of the particulars thereof are found to be omitted or incorrect it shall be the duty of the proper division registrar upon the error being reported to him within the time aforesaid to enquire into the same, and if satisfied that the entry is incorrect to correct the error according to the fact, entering the correction in the margin, without any alteration of the original entry, and shall note thereon the fact that the correction has been made and the date thereof. Correcting errors in registration.

(2) If the forms containing the original entry have been returned to the Registrar-General, the Registrar-General shall on evidence satisfactory to him correct the error in the margin of the form as well as in the indexed record thereof without altering the original entry, and shall note thereon the fact that the correction has been made and the date thereof. R.S.O., 1914, c. 49, s. 13. Correction after return of forms.

19. (1) Every division registrar shall supply free of charge, any form required by a person in order to comply with the provisions of this Act.

Division registrar to supply forms free of charge.

(2) The division registrar shall carefully examine every certificate of birth, marriage or death, in order to ascertain whether or not it has been made out in the prescribed form, and every such certificate of birth, marriage or death shall be written legibly in durable black ink and shall not be deemed to be complete unless it contains all the items of information called for therein or satisfactorily accounts for their omission.

Division registrar to see to correctness of certificate.

(3) If a certificate of death is incomplete or unsatisfactory it shall be the duty of the division registrar to call attention to the defects in the return and to withhold the permit for the burial or removal of the body until such defects are corrected.

Correcting defects.

(4) The division registrar shall number consecutively the registration of births, marriages and deaths in three separate series beginning with "No. 1," for the first birth, marriage and death in each calendar year and shall sign his name as division registrar in attestation of the date of the filing in his office.

Numbering registrations.

20. Every division registrar shall be charged with the enforcement of this Act in his registration division under the supervision and dircetion of the Registrar-General and he shall make an immediate report to the Registrar-General of any violation of the law which comes to his knowledge.

General duty of Division Registrar.

REGISTRATION OF BIRTHS

21. (1) Every legally qualified medical practitioner who attends at the birth of a child shall within forty-eight hours give notice thereof in the prescribed form to the division registrar of the division in which the child was born. R.S.O., 1914, c. 49, s. 14.

Duty of medical practitioner.

(2) If there is no physician in attendance it shall be the duty of the nurse in attendance or the occupier of the house in which the child was born, to give notice of the birth in the prescribed form to the division registrar.

Where no physician in attendance.

22. (1) When a child is born registration of the birth in the prescribed form shall be made with the division registrar in the division in which the child was born—

Who to register with.

(*a*) by the father if living; or

(*b*) in case of inability on the part of the father or if he is dead, then by the mother if living; or

(*c*) in case of inability on the part of both parents or in case both are dead, then by the person standing in the place of the parents of the child;

(*d*) if there is no father or mother or other person whose duty it is to register the birth, by the occupier of the house in which the child was born if he has knowledge of the birth, or by the nurse or other person present at the birth.

(2) The registration shall be made within thirty days after the date of the birth. R.S.O., 1914, c. 49, s. 15. Time for registering.

23. If a living new-born child is found exposed it shall be the duty of any person finding such child, and of any person in whose charge such child may be placed, to give, to the best of his knowledge and belief, to the division registrar of the division in which the child is found, within seven days after the finding of such child, such information of the particulars required to be registered concerning its birth as the informant possesses. R.S.O., 1914, c. 49, s. 16. Registration of foundlings.

24. A person shall not be named in the register as the father of an illegitimate child unless he and the mother request in writing that the name be so entered and the division registrar shall write the word "illegitimate" in the proper column. R.S.O., 1914, c. 49, s. 17. Illegitimate children.

25. The division registrar may register a birth at any time within one year after the birth occurred. R.S.O., 1914, c. 49, s. 18. Registration within one year after birth.

26. The Lieutenant-Governor in Council may make regulations for the registration of births which have not been registered under the foregoing provisions of this Act, and for the registration of a birth which has taken place while the mother of the child was temporarily absent from Ontario or on her way from some place out of Ontario to some locality in Ontario. R.S.O., 1914, c. 49, s. 19. Regulations as to registration of births out of Ontario.

27. (1) Where the birth of a child has been registered and the Christian or given name, if any, by which the child was registered has been changed or if the child was registered without a Christian or given name, the parent or guardian of the child or the person procuring the name to be changed or given may deliver to the division registrar a certificate signed by the minister, clergyman or other person who performed the rite of baptism upon which the Christian or given name was changed, or, if the child was not baptized, signed by the father, mother or guardian of the child procuring the Christian or given name of the child to be changed, and the division registrar shall upon the receipt of such certificate, make the necessary alteration in the margin of the form containing the original entry and in the transcription thereof without making any alteration in the original entry and shall also make the same correction in the index regarding such child. Change of name after registration.

(2) If the registration has been transmitted to the Registrar-General, the Registrar-General may make such alteration or addition and if the certificate cannot be procured from the minister, clergyman or other person who performed the rite of baptism upon which the name of the child was changed or given, the Registrar-General may make any alteration or addition in the registration of the name of the child upon such evidence as he may deem sufficient. R.S.O., 1914, c. 49, s. 20. Alteration of name in register.

28. (1) A child which is not alive at the moment of birth shall be deemed to be a stillborn child and stillbirths shall be registered as births and as deaths and a certificate of birth and of death shall be filed with the division registrar in the prescribed form. Stillborn children.

(2) The notice of the birth of stillborn child shall contain in place of the name of the child the words "stillborn." Notice of stillbirth

(3) The medical certificate of the cause of death in the case of a stillbirth shall be signed by the attending physician, if any, in the prescribed form, and where there is no physician in attendance the stillbirth shall be treated as a death taking place without medical attendance as provided for in section 35. Certificate.

(4) No child which shows any evidence of life after birth shall be registered as stillborn. When child not to be deemed stillborn

REGISTRATION OF MARRIAGES

29. (1) Every person who solemnizes a marriage shall report the same to the division registrar of the division within which the marriage was solemnized within thirty days thereafter with the particulars required in the prescribed form, but in case of a marriage solemnized under the authority of a license or certificate it shall be sufficient to report the same on the form attached to the license or certificate. Duty to report.

(2) The Lieutenant-Governor in Council may make regulations for the registration of marriages which have not been registered under the foregoing provisions of this act. R.S.O., 1914, c. 49, s. 21. Regulations for registration after thirty days.

REGISTRATION OF DEATHS

30. (1) The body of any person whose death occurs in Ontario shall not be removed for burial, interment, deposited in a vault or tomb, cremated or otherwise disposed of or removed from or into any registration division until a permit for that purpose has been properly issued by the division registrar of the division in which the death occurs after notice of the death has been filed with him in the prescribed form. Body not to be removed, etc., without permit.

(2) Where the death has occurred out of Ontario, or the burial or other disposition of the body is to take place in a registration division other than that in which the death has occurred, a certificate, signed by the division registrar or other proper officer of the municipality or place in which the death occurred shall be sufficient authority for the burial or other disposition of the body. Deaths out of Ontario.

31. The legally qualified medical practitioner who was last in attendance during the illness of any person shall within twenty-four hours after having knowledge of the death of such person, deliver or transmit to the division registrar of the division a notice of the death in the prescribed form. Duty of medical practitioner.

Duty of occupier of premises.

32. The occupier of the house in which a person dies, or if the occupier be the person who has died, then every adult person residing in the house in which the death took place, or if the death has not taken place within a house, then every person present at the death or having knowledge of the circumstances of the same shall, within twenty-four hours after having knowledge of such death, give notice of the death to the registrar of the division in the prescribed form. R.S.O., 1914, c. 49, s. 22 (1)*part.*

Registration in division other than that in which death occurs.

33. (1) Where a death has occurred and it is impracticable to register the same, by reason of distance, with the division registrar of the division in which the death occurred, notice of the death may be given to the nearest division registrar or sub-registrar who, upon the payment of a fee of 25 cents by the applicant, shall register the same in the prescribed form and issue a burial permit which shall be sufficient, and such division registrar or sub-registrar shall forward the return to the division registrar of the division in which the death occurred.

Fee of division registrar for burial permit.

(2) The division registrar issuing the burial permit shall be entitled to the fee for his own use. R. S. O., 1914, c. 49, s. 22 (2) (3).

Deaths in mines, camps, etc.

34. Where a death occurs in a camp or mine, before the removal of the body from the camp or mine, or its burial or other disposition, the manager or other person in charge shall, within twenty-four hours after the death, give notice thereof to the division registrar in the prescribed form, and where further particulars of a death occurring in a camp or mine are required by the division registrar, the same shall be immediately furnished by the owner of such camp or mine, or other person to the best of his knowledge and belief.

Where no medical attendance at death.

35. (1) Where a person has died without medical attendance no burial permit shall be issued by a division registrar unless and until notice has been given to him by the coroner that he has examined the body and made enquiry into the circumstances of the death as provided by *The Coroner's Act,* or until an inquest has been held and the coroner has furnished the particulars required in the prescribed form.

Regulations.

(2) Notwithstanding anything contained in subsection 1, the Registrar-General may make regulations providing for the issue of a burial permit where a death has taken place and there has been no legally qualified medical practitioner in attendance.

Burial permit.

36. Except as otherwise provided by this Act a division registrar shall immediately upon registering a death, deliver without charge to any person requiring the same for the purpose of burial or other disposition of a body, a burial permit in the prescribed form. R.S.O., 1914, c. 49, s. 26.

Sub-registrars.

37. (1) When upon proper representation to the Registrar-General, he is of opinion that in any section of Ontario, the registration of deaths for the purpose of burial would be facilitated, he may appoint a sub-registrar for the special purpose of issuing a burial permit upon the payment by the applicant of a fee of 25 cents.

(2) The sub-registrar shall register the death upon a special form of schedule provided and shall forthwith transmit the original form to the division registrar of the division in which the death occurred for registration by him, and the sub-registrar shall make monthly returns to the Registrar-General in compliance with the provisions of section 15 of this Act. R.S.O., 1914, c. 49, s. 22 (4), (5). Registration by sub-registrars.

38. In the case of the death of an infant under one year of age the division registrar shall not issue a burial permit until he has ascertained the place of birth of the child, and if the birth has taken place in the division of which he is registrar, he shall not issue a burial permit until he is satisfied that the birth has been registered. Registration of death of infant.

39. (1) A caretaker or owner of a cemetery or burial ground, whether public or private, or a clergyman or other person having charge of a church to which a cemetery or burial ground is attached shall not permit the interment of the body of any person in the cemetery or burial ground over which he has charge until he has received a burial permit from the proper division registrar. Caretaker, etc., and clergyman not to allow burial without permit.

(2) Every such caretaker, owner, clergyman or other person shall on or before the tenth day of each month in every year transmit to the division registrar of the division in which the cemetery or burial ground is situated, a return in the prescribed form of the burials therein during the previous month up to and including the last day of the month next preceding, for subsequent transmission to the Registrar-General. Returns from cemeteries, etc.

40. Where there is no person in charge of a cemetery or burial ground the undertaker or other person in charge of the burial or other disposition of the body shall write across the face of the burial permit the words "No person in charge," and shall append his signature thereto and shall return the burial permit so marked to the division registrar of the division in which the burial took place. Where there is no caretaker, etc., of cemetery.

LATE REGISTRATIONS

41. Where a birth, marriage or death has not been registered with the division registrar within one year after such birth or death took place, or such marriage was solemnized, the birth, marriage or death shall not be registered thereafter by the division registrar, but the Registrar-General may register the same upon being furnished with the required information in the prescribed form. Registration after one year.

Not only is such legislation desirable, but strict law enforcement is necessary if we are to have a satisfactory record of vital facts and proper and complete public health bookkeeping.

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CHAPTER XXIV

PUBLIC HEALTH, ORGANIZATION, ADMINISTRATION AND LEGISLATION

Historical.—The organized practice of preventive medicine under the direction of the government began in the British Isles centuries ago. These activities are to be distinguished from the individual efforts described in earlier times in sacred and secular writings. The books of Leviticus and Deuteronomy in the Old Testament contain many passages of much importance relating to the preservation of health. The earlier Greek and Roman civilization saw the beginnings of attempts to provide communal water supplies and methods for the disposal of filth and waste matter. In England, before the middle of the 16th century (1532) an Act of Parliament provided for the "institution of Commissions of Sewers in all parts of the Kingdom." (Simon.)

It was not, however, until 100 years later that Richard Mead the father of quarantine, made his observations which were destined to mark the beginning of a new epoch in preventive medicine. The great plague of 1663-1665, which in London had caused more than 100,000 deaths within one six month period, had swept over Europe unchecked. Interest in appropriate precautionary and preventive measures ran high and Mead's opinions and advice became crystallized in legal enactments in the reign of George I. The practice of curative medicine was hardly on a more substantial foundation at this time than was that of preventive medicine. Harvey's demonstration of the circulation of the blood had been made but a short time before in 1628.

Following Mead came Pringle and Lind the fathers respectively of British military and naval hygiene and preventive medicine. Pringle in the British campaigns in Flanders in 1742-3 made many interesting observations and as a result enunciated certain general principles of preventive medicine which if applied, would have resulted in a diminution in the incidence of typhus fever and enteric disease. Lind published a "Treatise of Scurvy" in 1753 and the

result of the adoption of his recommendations was that thousands of lives formerly sacrificed on account of ignorance were saved by the introduction of suitable dietetic measures. This was an early recognition of the fundamental relationship of nutrition to public health. Lind also strengthened and corroborated the observations of Pringle dealing with the probable identity of "hospital fever," "ship-fever" or "Jail fever" and typhus. He further indicated how the ravages of this disease might be lessened. In this he ably supported the teachings of Pringle.

One of the very early administrative procedures, proposed in concrete terms by Mead, was that of quarantine and while a quarantine of sorts, also placarding, existed prior to his time, Mead was the first to devise methods whereby it might be utilized as a measure of prevention with reasonable hope of success. This development dates back to 1663-4. The earlier applications of quarantine in Italy (Venice 1348 in connection with the outbreak of the Black Death; Reggio in Modena in 1374) and elsewhere were arbitrary and empirical in the extreme. Mead, however, based his suggestions on the view that plagues and pestilences were contagious and in consequence was sound to a degree that seems truly remarkable in the light of the views then current, as to etiology and modes of transmission of communicable diseases. Quarantine (derived from the Italian *quarante* meaning forty) originally was applied in such a fashion that the segregation of sick from the well (contacts) was not even contemplated, much less advised. Mead was probably the first to advise "that the best method for stopping infection is to separate the healthy from the diseased." He also emphasized the great importance of early recognition of cases. There is evidence then that sound practitioners of preventive and curative medicine combined, existed before the beginning of the 18th century.

A notable demonstration of the truth of the teaching of Pringle was given by Capt. Cook in his great voyage of discovery in the "Resolution" for which he received recognition from the Royal Society of London. Cook's voyage lasted for three years and eighteen days and with a crew of 118 only one man died from disease in all that long period despite innumerable hardships and difficulties. The application of hygienic rules and dietetic measures as enunciated by Lind explain the triumph in the field of preventive medi-

cine of this intrepid explorer. Other great names in this period of preventive medicine in England are those of Blane, Baker and Huxham, and following closely is that of Edward Jenner who made perhaps the greatest addition to the knowledge of specific preventive medicine or immunology. No other contribution before or since his time has quite the same significance as that of Jenner. He brought within immediate reach, the control of one of the most devastating of all diseases. In 1798 his great work, an "Inquiry into the Causes and Effects of the Variolae Vaccinae" was published.

Just one other feature of early organized and state directed preventive medicine or public health deserves mention here. In addition to quarantine to prevent the introduction of leprosy, plague, syphilis, etc., from the Orient into Europe and the British Isles, there had been built lazarettos or plague hospitals in various cities where patients could be concentrated. The first lazaretto established in a municipality was that founded by the City of Venice in the year 1403. In addition to the activities indicated, the destruction of possible sources of infection was carried out and disinfection or destruction of fomites was practiced in many communities.

The situation, then, at the beginning of the nineteenth century in practically all countries as regards the practice of preventive medicine and the conduct of public health work was, that a very meagre background of public health legislation existed; and that administrative procedure was limited practically to attempts to enforce quarantine of a sort that had little or no merit. The only substantial progress in any part of the English-speaking world was that which resulted from the work of Jenner in specific preventive medicine, and from that of Mead, Pringle, Lind and Blane in general preventive medicine.

From this point, while the same general tendencies and developments are to be observed in the subsequent history of preventive medicine in Great Britain, the United States, Canada and other British Dominions each of these has presented certain characteristics peculiarly its own. The development in the United Kingdom led the way and public health administration there has served as a pattern for many other communities. The first sanitary legislation of modern times in the British Isles was the Quarantine Act of 1825. Next was passed the Public Health Act of 1848, "The Nation's First Health Charter"; this was largely due to the persistent efforts of

Edwin Chadwick one of the pioneers in state medicine in England. This provided for the establishment of the first Board of Health in England.

In the British Isles the progress of preventive medicine was usually coincident with efforts to improve the general living conditions of great masses of the people, and social reformers such as Richard Owen, Lord Shaftesbury, and those of even earlier times like Wilberforce, the abolitionist, who did so much to bring slavery to an end, John Howard one of the greatest of modern humanitarians, whose interests included the progress of sanitary reforms and whose books on lazarettos (1789) are of interest to every student of preventive medicine; did much to make clear the close relationship existing between unfavorable social conditions and preventable diseases and deaths.

Sanitary legislation, therefore, was supplemented by social legislation and this is of especial interest to practitioners of curative as well as those of preventive medicine of the present day because the machinery set up by such legislative enactments required the services of physicians for its operation. One of the first of these was the Poor-Law Amendment Act of 1834 under which Poor-Law Medical Officers were appointed. The subsequent developments in this closely related field of endeavor are treated in detail in a most interesting manner by Sidney and Beatrice Webb in their work "The Prevention of Destitution." They indicate the views which were outlined in the Minority Report of the Poor-Law Commission of 1909 and amplify them. Then, too, a constructive policy is suggested for dealing with the many problems arising out of the imperfect organization existing in England for the prevention of destitution, to which disease and disability is so largely contributable. In this same connection another work by these authors "The State and the Doctor," should be consulted.

Owing to the unfortunate fact that relief rather than prevention was the key-note of much early nineteenth century legislation in England passed for the amelioration of certain social conditions there grew up a system of poor law medical relief which culminated in the passage in 1911 of of the National Insurance Act of that year which provided for a system of insurance against ill-health for all persons between certain ages and in receipt of incomes under a certain stipulated minimum. Thus as public health legislation was

being enacted a medical service for the treatment of the sick poor was also in the process of creation. There has been no precisely parallel development in the United States, Canada or in the other British Dominions.

Local Boards of Health in England and Wales were first required to be established in 1866. (Previous to this the first English medical officer of health, Dr. W. H. Duncan, for the municipality of Liverpool had been appointed in 1847). In 1872 was passed the English Public Health Act* which had been designated "The greatest sanitary code ever enacted in any country."

*This provided for what was outlined as the "national sanitary minimum of what is necessary for civilized social life" (Newman) and included:
(1) The supply of wholesome and sufficient water for drinking and washing.
(2) The prevention of the pollution of water.
(3) The provision of sewerage and utilization of sewage.
(4) The regulation of streets, highways and new buildings.
(5) The healthiness of dwellings.
(6) The removal of nuisances and refuse, and consumption of smoke.
(7) The inspection of food.
(8) The suppression of causes of diseases and regulations in case of epidemics.
(9) The provision for the burial of the dead without injury to the living.
(10) The regulation of markets, etc., public lighting of towns.
(11) The registration of death and sickness.

The early provision for registration of vital statistics has already been mentioned elsewhere. In 1890 and 1899, Acts providing for the notification of infectious diseases were passed and under an amendment to the Education Act of 1907 a national system of supervision of the health of children of school age was inaugurated.

Between the years 1848 and 1858 a Central Board of Health created by the Act of the former year was the central supervisory authority in matters of public health in England. The Board was abolished in 1858 and the Privy Council Committee assumed the functions of the board and was the Central Medical Authority from that year until 1871. Between the years 1871 and 1919 the Local Government Board was the central medical department of the Government, but other departments, notably the Home Office, the Board of Education, the Board of Trade, the Board of Agriculture, the National Insurance Commission all had delegated to them, in time, certain medical duties. In 1919 an Act came into effect which created a Ministry of Health.

This Act provided that, "for the purpose of promoting the health of the people throughout England and Wales, and for the purpose of the exercise of the powers transferred or conferred by this Act

it shall be lawful for his Majesty to appoint a Minister of Health, who shall hold office during his Majesty's pleasure."

"It shall be the duty of the Minister in the exercise and performance of any powers and duties transferred to or conferred upon him by or in pursuance of this Act to take all such steps as may be desirable to secure the preparation and effective carrying out and coordination of measures conducive to the health of the people, including measures for the prevention and cure of diseases, the avoidance of fraud in connection with alleged remedies therefor, the treatment of physical and mental defects, the treatment and care of the blind, the initiation and direction of research, the collection, preparation, publication and dissemination of information and statistics relating thereto, and the training of persons for health services."

The public health act of 1872 divided the country into sanitary districts or local health areas. The sanitary government of England and Wales (practically the same is true of Scotland and Ireland) is partly central and partly local. The function of the central authority is supervisory, that of the local authority executive. Grants-in-aid are sometimes made by the central to the local authorities to assist in defraying the cost of the conduct of certain types of public health work. In this way, up to 1919, tuberculosis dispensaries to the number of 380, school clinics (medical and dental) 580 in number; maternity and infant welfare centers 1,600 in all; 150 venereal disease clinics and various other special clinics had been established locally throughout England and Wales. The local health authority whether of a county or municipality is under the supervision and very often in receipt of financial assistance from the ministry of health.

In addition to the features outlined in the Act of 1872 provision has since been made by statute dealing among other things with:

1. The sale of food and drugs.
2. The pollution of rivers.
3. Housing of the working classes.
4. Prevention of infectious diseases (notification).
5. Factory and workshops (inspection).
6. Isolation hospitals.
7. Education Acts (dealing with blind and deaf children; defective and epileptic children; provision of meals; medical treat-

ment; medical inspection and treatment of children and young persons).

8. Cleansing of persons.
9. Midwives.
10. Employment of children.
11. Notification of births.
12. Housing and town planning.
13. National (Health) Insurance.
14. Mental deficiency.
15. Milk and dairies.
16. Venereal diseases.
17. Maternal and child welfare.

In addition, administrative provision has been made for dealing with maternal and infant mortality, venereal diseases, tuberculosis and various other important problems of preventive medicine. Just a word of mention should here be made of the National Research Council which is under a Committee of the Privy Council although supported by funds raised under the National Insurance Act. Most important and valuable research work in public health is conducted by this Council. The reader interested in further details of the rise and progress of public health in England is referred to that classic of history of preventive medicine, Sir John Simon's "English Sanitary Institutions," for an account of more recent developments to Newman's "Outline of the Practice of Preventive Medicine" and Newsholme's "Insurance and Other Addresses," and to the Reports of the Chief Medical Officer, Local Government Board 1871-1919.

In the United States public health organization, federal, state and local is provided for under the constitution of the United States and by virtue of state laws and municipal ordinances, "The jurisdiction of the Federal Government in public health matters extends over foreign intercourse, interstate intercourse, federal territory, and federal administrative affairs including protection of the Indian tribes." (Kerr.) The early history of federal public health activities is practically an account of the development of the United States Public Health Service. According to Kerr, in 1796, a national law was passed which provided that revenue officers and revenue cutters, acting under orders from the President were to aid in the execution of quarantine. This seems to have been the first

national public health activity in the United States as it was in England. The present Federal public health service had its beginnings in the Marine Hospital Service, the establishment of which was authorized by Congress in 1798. This service was created to provide medical care for sick and disabled seamen of the American Merchant Marine. Those seamen who were in need of such care were to receive it in special marine hospitals maintained by the United States Government for the purpose or in civilian institutions. A marine hospital fund was obtained by the imposition of a tax of 20 cents per capita on all seamen employed on American vessels engaged in foreign and coasting trade. This tax was collected through collectors of the customs and as a result the Marine Hospital Service came under the jurisdiction of the Treasury Department where it has ever since remained.

Marine hospitals were first built in Norfolk, Va., in 1800, in Boston in 1802, and at other seaports in the course of time. Gradually the Marine Hospital Service personnel came to be employed for federal public health purposes. First it consisted in diagnosing cases of communicable diseases, such as cholera, yellow fever, smallpox, etc., among seamen, and then in assisting state and local health authorities in providing relief and gaining control of these diseases.

In 1878, Congress passed the first permanent quarantine law, "the result of the widespread and severe epidemic of yellow fever during the previous year," (Kerr). This conferred wide powers and imposed certain duties on the Marine Hospital Service requiring cooperation with state and local health departments in the control of communicable diseases, especially yellow fever. This act really delegated to the Marine Hospital Service the function of preventing the entrance of cases of communicable diseases into the United States from foreign countries. In 1890 the Service was by Congress made the Federal agency for the prevention of the interstate spread of communicable diseases. The Act of that year stipulated that the service was to be used for the prevention of cholera, yellow fever, plague and smallpox only. This was extended in 1893 to cover all communicable diseases "in cooperation with States and local health agencies."

In 1889 a Marine Hospital Corps was organized along lines somewhat similar to the Medical Corps of the United States Army. A

Surgeon-General was provided for and his duties stipulated by Acts of Congress of 1870 and 1875. The Act of 1893 really converted the Marine Hospital Service into the Federal Health Service. In 1902 the name of the Service was changed to the Public Health and Marine Hospital Service. Between 1893 and 1902 various additional health functions were imposed upon the Service. Up until 1893 the care of sick mariners and combating epidemics, constituted a large share of the duties performed. Research and educational work in the service was given a great impetus in the establishment in that year of the Hygienic Laboratory. This has divisions of pathology and bacteriology, zoology, pharmacology, chemistry and physiology. With a total personnel of 119 and thoroughly equipped, this is one of the most important public health research laboratories in the world. The scientific contributions of officers of the Service detailed for duty in this Laboratory have been numerous and in many instances have been of very great value from both a scientific and immediately practical standpoint.

In 1912, Congress changed the name of the Service to the United States Public Health Service; under which name it is known at the present time. In that year also powers were conferred on the Service to investigate the diseases of man and also to study the question of the pollution of navigable streams and lakes in the United States. The functions of the United States Public Health Service as outlined at present by statute in addition to its hospital functions are:

1. "Protection of the United States from the introduction of disease from without."
2. "Prevention of the interstate spread of disease, and suppression of epidemics."
3. "Cooperation with state and local boards of health in health matters."
4. "Investigation of diseases of man."
5. "Supervision and control of biological products."
6. "Public health education and dissemination of health information."

The United States Public Health Service is a Bureau in the Treasury Department and is in charge of a Surgeon-General appointed by the President "by and with the advice and consent of the Senate." The Surgeon-General is responsible to the Secretary of the Treas-

ury. The work of the Service is conducted by seven administrative divisions created by law, these are:

1. Division of Marine Hospitals and Relief.
2. Division of Domestic Quarantine.
3. Division of Foreign and Insular Quarantine.
4. Division of Personnel and Accounts.
5. Division of Sanitary Reports and Statistics.
6. Division of Scientific Research.
7. Division of Venereal Diseases.

There is in addition, a General Inspection Service, a Purveying Service, a Section on Health Education and the Office of the Chief Clerk.

Each administrative division is in charge of an Assistant Surgeon-General.

The organization of the personnel in the field consists of:

Regular Commissioned Officers	119
Reserve Commissioned Officers (active)	884
Reserve Commissioned Officers (inactive)	391
Scientific Personnel	297
Attending Specialists	190
Acting Assistant Surgeons	590
Administrative Assistants	172
Interns	34
Nurses	1,418
Dietitians	126
Reconstruction aides	460
Clerks	1,611
Other Employees	9,114
Total	**15,486**

Marine Hospitals and Relief.—"The Division of Marine Hospitals and Relief furnishes hospital and dispensary treatment to Federal beneficiaries as prescribed by law, such as patients of the War Risk Insurance Bureau, Federal Board for Vocational Education, U. S. Employees' Compensation Commission, Coast Guard, Merchant Marine, etc. This division is operating at this time (May, 1921) 61 hospitals, including one leprosarium. The total bed capacity of the 61 hospitals is approximately 18,500. Additional hospitals are about to be opened, which will increase the number of beds by approximately 3,000."

Domestic Quarantine.—"The Division of Domestic Quarantine

puts into operation measures for the suppression of plague; control of water supplies used by interstate carriers; prevention of epidemics, by building up and improving divisions of communicable diseases and sanitary engineering in State health departments.''

Foreign and Insular Quarantine.—''The Division of Foreign and Insular Quarantine supervises the administration of 97 maritime and border quarantine stations in the United States and its possessions, and is responsible for the proper enforcement of the United States quarantine laws and regulations; supervises the operations and medical inspection of aliens at the various ports of entry in the United States, which exceed 90 in number; and directs the operations of medical officers assigned to American consulates for the purpose of enforcing the United States quarantine laws applicable at foreign ports of departure.''

Personnel and Accounts.—''The Division of Personnel and Accounts provides professional, scientific, and other personnel for the execution of the various activities of the Service, including treatment of the beneficiaries of the Bureau of War Risk Insurance. The financial section under this division has charge of the pay rolls, auditing of vouchers, the placing of allotments, the preparation of estimates for appropriations to be submitted to Congress, and all financial matters of the Service.''

Sanitary Reports and Statistics.—''The Division of Sanitary Reports and Statistics collects and publishes information regarding the prevalence and geographic distribution of diseases dangerous to the public health in the United States and foreign countries. Court decisions, laws, regulations and ordinances pertaining to the public health are compiled, digested, and published. Its publications contain articles on subjects relating to the public health. This division issues Public Health Reports (weekly), its supplements and reprints.''

Scientific Research.—''The Division of Scientific Research conducts scientific field and laboratory studies of diseases of man and other public health problems. Among the diseases studied are anthrax, amebiasis, botulism, deer fly fever, hookworm, influenza, leprosy, malaria, meningitis, pellagra, pneumonia, plague, poliomyelitis, syphilis and related diseases, trachoma, tuberculosis, and typhoid fever. Studies and investigations are also made in matters relating to child hygiene, industrial waste, public health organiza-

tion and administration, sewage disposal, pollution of streams, and excreta disposal. In addition to these studies the division has charge of the following lines of work: Demonstration work in rural sanitation; treatment of cases of trachoma in hospital and field clinics for the purpose of suppressing that disease and supervision of the manufacture and sale of viruses, serums, toxins, and analogous products, including arsphenamine and neoarsphenamine, in interstate traffic."

Venereal Diseases.—"The Division of Venereal Diseases promotes the coordination of State boards of health in venereal disease control; prepares educational material; stimulates the improvement and standardization of methods of diagnosis, treatment, and control of venereal diseases; and stimulates greater activity through wide appeal and education of the public."

General Inspection Service.—"The General Inspection Service makes systematic inspections of all stations and activities of the Service, and investigates complaints regarding the administration of hospitals and personal conduct of United States Public Health Service officers, with subsequent report to the Surgeon-General."

Purveying Service.—"The Purveying Service attends to the purchase, care, storage, and issue of property, such as drugs and hospital, laboratory, and office supplies and equipment; motor vehicles and repair parts for mechanical equipment."

Public Health Education.—"The Section on Public Health Education supplies a daily health column, 'Uncle Sam, M.D.,' for publication in newspapers throughout the country, combined with a system of questions and answers; supplies news on health matters two or three times a week to 10,000 newspapers, periodicals, and organizations; supplies health articles to the Foreign Information Bureau; and produces motion-picture films and administers a stereopticon loan library."

Affiliations

(a) "**With State and Local Organizations.**—The United States Public Health Service cooperates and renders active assistance in the enforcement of quarantine laws, the suppression of epidemics, and the drafting of legislation; in making surveys; in venereal disease work and rural sanitation; and in the prevention and control of malaria."

(b) **With Voluntary Health Agencies.**—"The Service cooperates with: The International Sanitary Bureau of the American Republics; American Social Hygiene Association; Rockefeller International Health Commission; National Committee for Mental Hygiene; Institute of Tropical Medicine (Porto Rico); National Tuberculosis Association; National Health Council (consulting member of); American Red Cross (which gives social service in U. S. Public Health Service Hospitals and handles the recruiting of them); and American Legion."

(c) **With Official Agencies.**—"The Service furnishes medical care and treatment for the following beneficiaries:"

1. "Those persons employed, on board, in the care, preservation, or navigation of any registered, enrolled, or licensed vessel of the United States, or in the service, on board, of those engaged in such care, preservation, or navigation."
2. "Seamen employed on yachts, provided the said yachts are enrolled, licensed, or registered as vessels of the United States."
3. "Seamen employed on United States Army transports or other vessels belonging to the United States Army, when not enlisted men of the Navy."
4. "Officers and enlisted men of the United States Coast Guard."
5. "Officers of the Public Health Service and employees devoting all their time to field work."
6. "Seamen employed on vessels of the Mississippi River Commission."
7. "Seamen employed on the vessels of the Engineer Corps of the Army."
8. "Officers, crews of vessels, keepers and assistant keepers of the Lighthouse Service."
9. "Officers and seamen on vessels of the Coast and Geodetic Survey."
10. "Civil employees of the United States who are injured while in the performance of their duties."
11. "Patients of the Bureau of War Risk Insurance." "The Public Health Service details physicians to the: International Office of Public Hygiene, Paris; International Joint Commission; United States Employees' Compensa-

tion Commission; Bureau of Internal Revenue; Department of Agriculture, Bureau of Chemistry; Department of Interior, Bureau of Mines and Bureau of Education; Interdepartmental Social Hygiene Board; Hawaiian Government, Sanitary Advisor; Chief Quarantine Officer, Panama Canal; Federal Board for Vocational Education; and Bureau of War Risk Insurance."

TABLE XCI

ESTIMATES AND APPROPRIATIONS FOR PUBLIC HEALTH WORK FOR THE USE OF THE PUBLIC HEALTH SERVICE FOR THE FISCAL YEAR ENDING JUNE 30, 1920, (OCT. 25, 1919.)

NAME OF FUND	AMOUNT ESTIMATED FOR 1920	AMOUNT APPROPRIATED BY CONGRESS UP TO OCT. 20, 1919
Pay of commissioned officers and pharmacists	[1]$450,000	[2]$425,000
Pay of acting assistant surgeons	[1]175,000	[2]150,000
Pay of other employees	[1]370,000	[2]350,000
Clerical help in bureau	[1]46,500	[2]46,485
Transportation	[1]20,000	[2]20,000
Maintenance of Hygienic Laboratory	50,000	27,000
Quarantine service	200,000	200,000
Epidemic fund	400,000	400,000
Field investigations and diseases of man	1,050,000	300,000
Prevention of interstate spread of disease	850,000	25,000
Rural hygiene	500,000	50,000
Control of biological products	100,000	35,000
Control of venereal diseases	1,085,840	200,000
Studies in pellagra	30,000	30,000
Total	**$5,327,340**	**$2,258,485**

[1]This amount is one-half of the total fund estimated for this item for the whole service.
[2]This amount is one-half of the total appropriation for this item for the whole service.

The organization chart (Fig. 121) of the United States Public Health Service serves to illustrate in diagrammatic fashion the scope of Federal public health work.

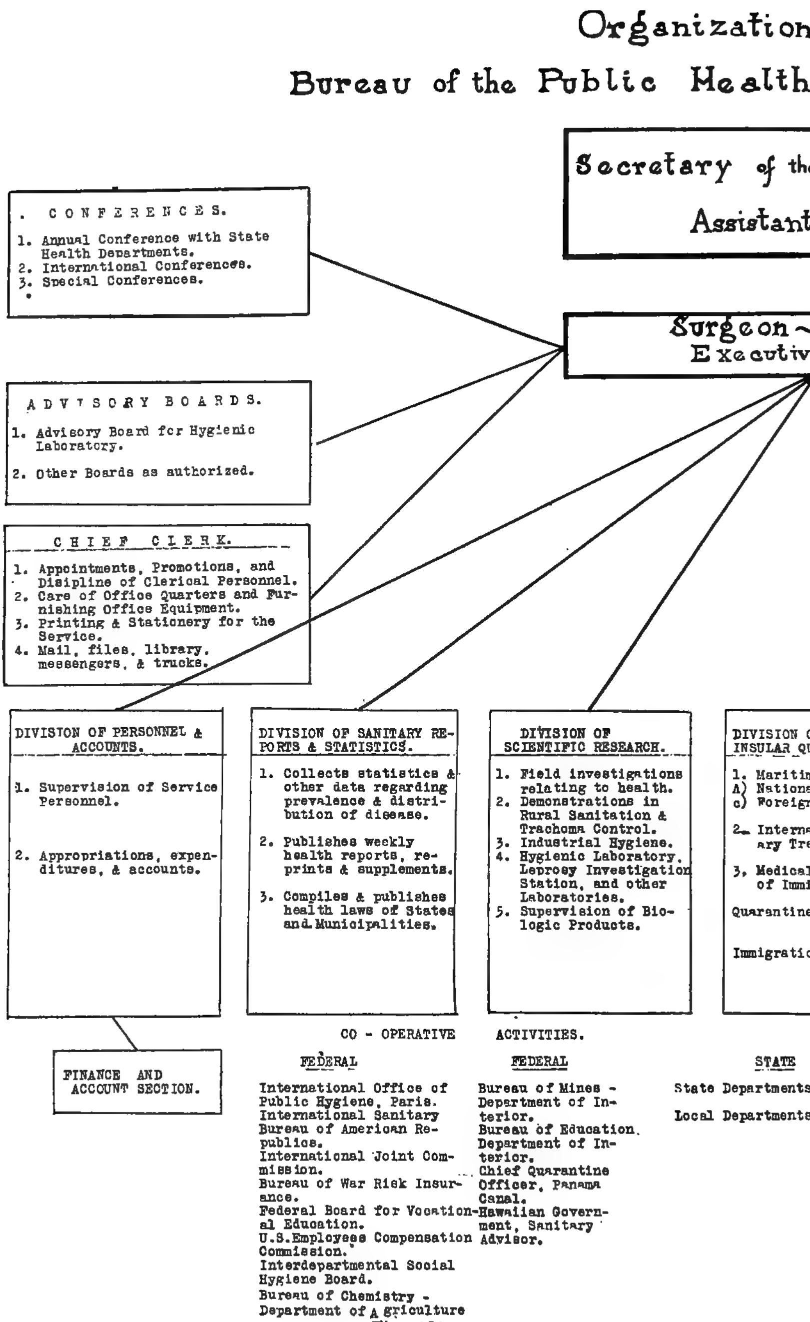
Organization and Administration of State Departments of Health.—There are in the United States at the present time 48 state departments of health or some central sanitary organization. According to Chapin there was in Louisiana in 1855 a State Board of Health which was concerned solely with quarantine. This apparently was the first state sanitary organization. In Massachusetts a state department of health was organized in 1869 and this was "the first state board to be organized for the general purpose of promoting

the public health'' (Chapin). There was prior to this time in that state what was known as the Massachusetts Sanitary Organization.

In practically all of the States there are State Boards of Health. The number of members of the board varies from 3 to 13 in different states. Most commonly the board is appointed by the Governor. In some states the Governor appoints certain of the members while others are ex-officio members. In still other states the organized medical profession nominates a certain number of members of the board. Originally the functions of state boards of health were advisory and investigative, and in some the administration of quarantine was also important. The duties of these boards have been greatly increased and *judicial*, *legislative* and *executive* functions are now included in practically all of them.

Certain judicial or quasi-judicial functions are sometimes performed by the State Department of Health. The investigation of alleged nuisances, instances of food adulteration, of stream pollution, etc., are examples of the exercises of this function. State departments of health are created by statutes and under these, their powers and duties are outlined in detail. The extent of the legislative power conferred varies in different states. Practically all have authority to formulate health regulations. The exact powers of a state department of health may at any time require to be determined by the courts. Public health legislation requires to be very carefully considered before being enacted. The body of public health law in many states provides that the state department of health may enact rules and regulations relating to matters affecting the public health such as the control of communicable diseases, disinfection, control of milk and other food, protection of water supplies, disposal of sewage, registration of vital statistics, etc.

The exact limitation of authority of the state department of health varies greatly in different states but in practically all the state department has more or less control over the local departments. In a general way the state departments usually undertake to regulate the control of communicable diseases, to supervise all sanitary engineering works, to provide for laboratory service (diagnostic and the distribution of public health biological products), to give demonstrations in certain special fields, to conduct public health educa-



Organization
Bureau of the Public Health
Secretary of th
Assistant
Surgeon
Executiv
CONFERENCES.
1. Annual Conference with State Health Departments.
2. International Conferences.
3. Special Conferences.
ADVISORY BOARDS.
1. Advisory Board for Hygienic Laboratory.
2. Other Boards as authorized.
CHIEF CLERK.
1. Appointments, Promotions, and Disipline of Clerical Personnel.
2. Care of Office Quarters and Furnishing Office Equipment.
3. Printing & Stationery for the Service.
4. Mail, files, library, messengers, & trucks.
DIVISION OF PERSONNEL & ACCOUNTS.
1. Supervision of Service Personnel.
2. Appropriations, expenditures, & accounts.
DIVISION OF SANITARY REPORTS & STATISTICS.
1. Collects statistics & other data regarding prevalence & distribution of disease.
2. Publishes weekly health reports, reprints & supplements.
3. Compiles & publishes health laws of States and Municipalities.
DIVISION OF SCIENTIFIC RESEARCH.
1. Field investigations relating to health.
2. Demonstrations in Rural Sanitation & Trachoma Control.
3. Industrial Hygiene.
4. Hygienic Laboratory, Leprosy Investigation Station, and other Laboratories.
5. Supervision of Biologic Products.
DIVISION
INSULAR QU
1. Maritin
A) Nationa
c) Foreign
2. Interna
ary Tre
3. Medical
of Immi
Quarantine
Immigratio
FINANCE AND ACCOUNT SECTION.
CO - OPERATIVE ACTIVITIES.
FEDERAL
International Office of Public Hygiene, Paris.
International Sanitary Bureau of American Republics.
International Joint Commission.
Bureau of War Risk Insurance.
Federal Board for Vocational Education.
U.S. Employees Compensation Commission.
Interdepartmental Social Hygiene Board.
Bureau of Chemistry - Department of Agriculture
FEDERAL
Bureau of Mines - Department of Interior.
Bureau of Education. Department of Interior.
Chief Quarantine Officer, Panama Canal.
Hawaiian Government, Sanitary Advisor.
STATE
State Departments
Local Departments

Fig. 121.

Chart .

Service.

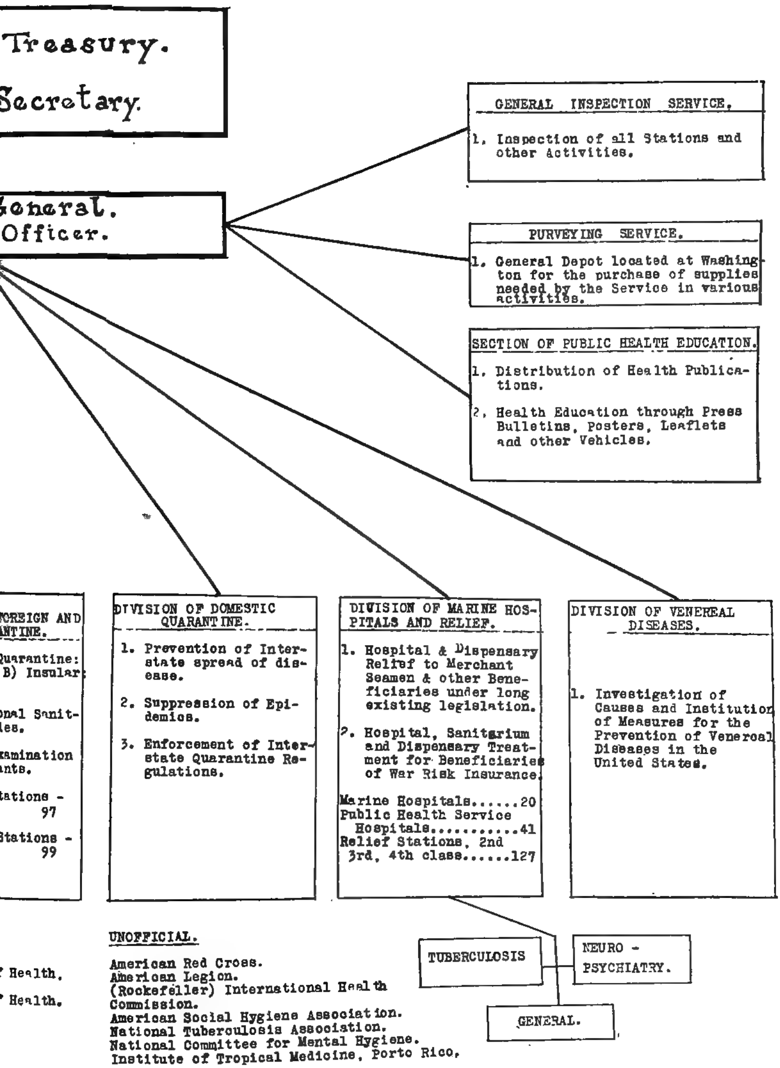


Fig. 121.

tional work and more recently to conduct public health clinics for venereal diseases, tuberculosis, infant and child hygiene, etc.

Every physician should be familiar not only with municipal public health ordinances, but also with the public laws of his own state.

The exact character of the public health work, the appropriations available for the support of such work, and the personnel employed also varies in the different states. A very complete survey was made by Chapin a few years ago under the direction of the Council on Health and Public Instruction of the American Medical Association. Those interested in the details of organization, administration, etc., of the various State Health Departments should consult this very valuable report. Certain States have featured a special type of public health work, and have thereby been able to accomplish much in a particular field. An example of this is seen in North Carolina where rural public health work has been conducted most energetically under Dr. Rankin, the able Commissioner of Health of that state.

In general what is required for adequate public health work in any state is first, sound and adequate public health laws, an appropriation sufficiently large to grapple with the public health problems which present themselves, and finally stability of tenure of office for state health officers, or in other words untramelled freedom from political control. Chapin, in referring to this in the Report already mentioned, states "a review of public health conditions in the States today indicates that by far the greatest hindrance to progress is the terrible incubus of politics. It seems incredible that the citizens of an otherwise progressive state are perfectly content to see their health officers elected with no regard for fitness or training, but simply because they or their friends were helpful to the political party which was successful at the last election."

Given stable administration and a well-trained personnel, the usefulness of any state department of health is determined very largely by the size of the appropriation made for public health purposes. This has been emphasized in the motto of the New York State Department of Health "Public Health is purchasable; within natural limitations, any community can determine its own death rate."

Since this is such a vital matter in relation to the proper conduct of state public health work, the accompanying financial statistics

PUBLIC HEALTH ORGANIZATION

STATE OF NEW YORK

GOVERNOR

COMMISSIONER OF HEALTH

DEPUTY COMMISSIONER

SECRETARY

EXECUTIVE CLERK

Public Health Council
(Consisting of the Commissioner and six members appointed by the Governor, three must be physicians)

Consulting Staff

DIVISIONS
(Each with a Director)

1. Sanitary Engineering
2. Laboratories and Research
3. Vital Statistics
4. Communicable Diseases
5. Child Hygiene
6. Public Health Nursing
7. Public Health Education
8. Tuberculosis
9. Venereal Diseases

District Sanitary Supervisors	15
Appropriations — 1920	$1,036,974.83
Estimate Population excluding New York City	6,000,000

Fig. 122.

of state departments of health compiled by C. St. Clair Drake, Secretary of the Conference of State and Provincial Health Authorities of North America, are given in detail.

The plan of organization of the New York State Department of Health is shown in Fig. 122, and there is also included a statement of estimated population and the public health appropriation for the year 1920.

The public health code of the state specifies the judicial and quasi-judicial powers of the State Department of Health and also the executive functions conferred upon it. The administrative duties of the commissioner are outlined and the execution of these carried out through the various divisions of the department. The

Table XCII

Financial Statistics of State Departments of Health

Compiled Under the Direction of Dr. C. St. Clair Drake, Secretary, Conference of State and Provincial Health Authorities, December, 1920

State	Population	Area (square miles)	Health appropriation						Salary, executive officer		
			Total		Per capita		Per square mile		Total	Per 1,000 population	Per 100 square miles
			Amount	Rank	Amount	Rank	Amount	Rank			
					Cents						
Alabama	2,347,295	51,279	$140,000	16	6.0	25	$ 2.73	20	$5,000	$2.13	$9.75
Arizona	333,273	113,020	21,500	40	6.5	21	.19	43	1,000	3.00	.88
Arkansas	1,750,995	52,525	60,955	31	3.5	35	1.17	34	3,000	1.71	5.72
California	3,426,536	156,092	307,200	7	8.9	14	1.97	24	4,500	1.31	2.88
Colorado	939,376	103,658	48,250	33	5.1	27	.47	37	2,000	2.13	1.93
Connecticut	1,380,585	4,820	177,500	13	12.9	9	36.80	4	4,000	2.90	83.00
Delaware	223,003	1,965	22,000	39	9.9	11	11.20	6	3,000	13.43	152.80
District of Columbia	437,571	....	....	....	....	....	....	....	4,000	9.14	....
Florida	966,296	54,861	155,000	14	16.6	6	2.83	19	3,000	3.12	5.47
Georgia	2,894,683	58,725	115,000	21	4.0	32	1.96	25	5,000	1.73	8.51
Idaho	431,826	83,779	29,050	37	6.7	20	.35	39	3,000	6.95	3.58
Illinois	6,485,098	56,002	332,173	6	5.1	28	5.93	12	6,000	.93	10.70
Indiana	2,930,544	35,885	130,000	20	4.4	30	3.62	15	3,000	1.02	8.35
Iowa	2,403,630	55,586	77,588	27	3.2	39	1.40	29	3,000	1.25	5.40
Kansas	1,769,257	81,774	111,885	22	6.3	22	1.37	30	4,000	2.26	4.90
Kentucky	2,416,013	40,181	135,000	18	5.6	26	3.36	16	1,200	.50	2.99
Louisiana	1,797,798	45,409	60,000	32	3.3	37	1.32	32	5,000	2.78	11.00
Maine	768,014	29,895	67,929	30	8.8	15	2.27	21	4,600	5.98	15.40
Maryland	1,449,610	9,941	179,711	12	12.4	10	18.05	5	3,750	2.59	37.75

Massachusetts	3,852,356	8,039	1,513,174	2	39.2	1	188.00	1	7,500	1.95	93.40
Michigan	3,667,222	57,480	230,137	10	6.3	24	4.01	14	4,500	1.23	7.85
Minnesota	2,386,371	80,858	97,037	25	4.1	31	1.20	33	4,500	1.88	5.57
Mississippi	1,789,384	46,362	138,494	17	7.7	18	2.99	18	3,600	2.01	7.77
Missouri	3,403,547	68,727	20,000	43	.6	46	.29	40	2,400	.71	3.49
Montana	547,593	145,776	131,077	19	23.9	3	.90	35	5,000	9.14	3.44
Nebraska	1,295,502	76,808	103,888	23	8.0	16	1.35	31	3,000	2.32	3.91
Nevada	77,407	109,821	...	...	...	...	...	...	...	...	...
New Hampshire	443,083	9,031	28,000	38	6.3	23	3.10	17	3,000	6.77	33.20
New Jersey	3,155,374	7,514	292,090	8	9.3	12	38.70	3	4,000	1.28	53.25
New Mexico	360,247	122,580	13,000	45	3.6	33	.11	46	3,000	8.34	2.44
New York	10,384,144	47,654	956,550	3	9.2	13	2.01	23	8,000	.77	16.78
North Carolina	2,556,486	48,740	344,838	5	13.5	8	7.08	10	5,000	1.96	10.25
North Dakota	645,730	70,183	11,634	48	1.8	45	.17	45	1,200	1.86	1.71
Ohio	5,759,368	40,740	197,540	11	3.4	36	4.85	13	6,000	1.04	14.78
Oklahoma	2,027,564	69,414	145,300	15	7.1	19	2.10	22	3,600	1.77	5.18
Oregon	783,389	95,607	17,000	44	2.1	43	.18	44	4,000	5.05	4.18
Pennsylvania	8,720,159	44,832	2,682,064	1	30.8	2	5.98	11	10,000	1.15	22.30
Rhode Island	604,379	1,067	48,000	34	7.9	17	45.00	2	3,500	5.80	328.00
South Carolina	1,683,662	30,495	235,566	9	14.0	7	7.72	8	4,000	2.38	13.13
South Dakota	635,839	76,868	21,000	41	3.3	38	.27	41	2,000	3.15	2 61
Tennessee	2,337,459	41,687	72,908	28	3.1	40	1.75	27	3,500	1.50	8.40
Texas	4,661,027	262,398	97,700	24	2.1	44	.37	38	3,000	.64	1.14
Utah	449,446	82,184	20,500	42	4.6	29	.25	42	4,000	8.90	4.87
Vermont	352,421	9,124	70,000	29	19.8	4	7.68	9	3,500	9.95	38.35
Virginia	2,306,361	40,262	382,289	4	16.6	5	9.50	7	4,200	1.82	10.42
Washington	1,356,316	66,836	33,557	36	2.5	42	.50	36	5,000	3.68	7.48
West Virginia	1,463,610	24,022	44,940	35	3.1	41	1.87	26	4,800	3.28	19.95
Wisconsin	2,631,839	55 256	94,450	26	3.6	34	1.71	28	6,000	2.28	10.85
Wyoming	194,402	97,184	...	...	...	...	...	...	(1)	...	...

(1) $10 per day.

Table XCII—Continued

Financial Statistics of State Departments of Health

Compiled Under the Direction of Dr. C. St. Clair Drake, Secretary, Conference of State and Provincial Health Authorities, December, 1920

State	Salaries—Chiefs of divisions.																	
	Engineering			Communicable diseases			Laboratory			Vital statistics			Child hygiene			Venereal disease		
	Total	Per 1,000 population	Per 100 square miles	Total	Per 1,000 population	Per 100 square miles	Total	Per 1,000 population	Per 100 square miles	Total	Per 1,000 population	Per 100 square miles	Total	Per 1,000 population	Per 100 square miles	Total	Per 1,000 population	Per 100 square miles
Alabama	$2,652	$ 1.13	$ 5.17	$3,000	$ 1.28	$ 5.85	$3,000	$ 1.28	$ 5.85	$3,300	$ 1.41	$ 6.44	$2,400	$ 1.02	$ 4.68	$3,000	$ 1.28	$ 5.85
Arizona	......	......	......	......	......	......	......	......	......	......	......	......	600	1.80	.53	1,500	4.50	1.32
Arkansas	3,000	1.71	5.72	......	......	......	......	......	......	2,100	1.20	4.00	......	......	......	1,500	.86	2.86
California	4,000	1.17	2.56	4,000	1.17	2.56	......	......	......	2,400	.70	1.54	3,600	1.05	2.30	......	......	......
Colorado	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	3,000	3.20	2.90
Connecticut	[2]2,500	1.81	51.80	3,000	2.17	62.20	[2]2,500	1.81	51.80	1,000	.73	20.70	2,400	1.74	49.80	......	......	......
Delaware	......	......	......	......	......	......	[3]3,000	13.43	152.80	1,000	4.48	50.90	......	......	......	2,100	9.40	107.00
Florida	3,000	3.12	5.47	......	......	......	3,000	3.12	5.47	2,750	2.86	5.02	2,700	2.81	4.92	3,000	3.12	5.47
Georgia	3,000	1.04	5.11	......	......	......	3,500	1.21	5.96	3,500	1.21	5.96	......	......	......	4,000	1.38	6.82
Illinois	4,000	.62	7.15	3,600	.55	6.42	3,600	.55	6.42	2,400	.37	4.28	4,000	.62	7.15	4,800	.75	8.75
Indiana	......	......	......	......	......	......	3,500	1.19	9.75	1,800	.61	5.01	1,800	.61	5.01	1,500	.51	4.18
Iowa	2,500	1.04	4.50	......	......	......	......	......	......	......	......	......	......	......	......	[4]4,000	1.66	7.20
Kansas	......	......	......	3,300	1.86	4.04	......	......	......	2,400	1.36	2.94	2,500	1.41	3.06	2,500	1.41	3.06
Kentucky	......	......	......	......	......	......	3,000	1.24	7.46	3,000	1.24	7.46	2,400	1.00	5.98	3,600	1.50	8.97
Louisiana	3,000	1.67	6.61	......	......	......	......	......	......	2,500	1.39	5.50	2,500	1.39	5.50	4,500	2.50	9.91
Maine	1,800	2.34	6.02	2,300	2.99	7.70	2,700	3.52	9.02	1,000	1.30	3.34	2,500	3.26	8.35	2,500	3.26	8.35

Maryland	3,000	2.07	30.20	3,000	2.07	30.20	3,000	2.07	30.20	2,400	1.66	24.16	......	......	......	......	......	......
Massachusetts	6,000	1.56	74.60	4,500	1.17	56.00	4,000	1.04	49.80	......	......	......	4,000	1.04	49.80	......	......	......
Michigan	3,000	.82	5.22	3,000	.82	5.22	3,000	.82	5.22	......	......	......	2,400	.66	4.18	3,000	.82	5.22
Minnesota	4,025	1.68	4.99	4,025	1.68	4.99	......	......	......	2,000	.84	2.47	180	.08	.22	2,500	1.05	3.10
Mississippi	......	......	......	......	......	......	2,700	1.51	5.83	2,700	1.51	5.83	......	......	......	3,000	1.68	6.47
Missouri	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	3,600	1.06	5.24
Montana	2,400	4.38	1.65	4,200	7.67	2.89	3,000	5.47	2.06	......	......	......	......	......	......	3,000	5.47	2.06
Nebraska	2,000	1.55	2.61	2,500	1.93	3.26	2,400	1.85	3.12	1,200	.93	1.56	......	......	......	3,000	2.32	3.91
New Hampshire	3,000	6.77	33.20	......	......	......	2,000	4.52	22.15	......	......	......	......	......	......	2,400	5.42	26.59
New Jersey	3,600	1.14	47.80	3,000	.96	39.94	4,000	1.28	53.25	3,000	.96	39.94	3,000	.96	39.94	3,000	.96	39.94
New Mexico	2,400	6.67	1.96	2,400	6.67	1.96	......	......	......	......	......	......	......	......	......	......	......	......
New York	5,500	.53	11.53	4,000	.39	8.40	7,000	.68	14.68	4,250	.41	8.92	4,500	.43	9.45	4,000	.39	8.40
North Carolina	3,000	1.18	6.15	......	......	......	4,000	1.57	8.21	2,500	.98	5.13	2,500	.98	5.13	3,000	1.18	6.15
North Dakota	2,200	3.41	3.14	......	......	......	......	......	......	......	......	......	......	......	......	3,000	4.65	4.27
Ohio	4,000	.70	9.82	3,300	.57	8.13	3,000	.52	7.39	......	......	......	2,400	.42	5.91	3,000	.52	7.39
Oklahoma	2,000	.99	2.89	......	......	......	1,800	.89	2.59	......	......	......	......	......	......	3,000	1.49	4.34
Oregon	......	......	......	......	......	......	3,000	3.79	3.14	1,800	2.27	1.88	1,800	2.27	1.88	2,400	3.03	2.51
Pennsylvania	6,000	.69	13.40	4,000	.46	8.92	4,000	.46	8.92	4,000	.46	8.92	3,000	.35	6.70	4,000	.46	8.92
Rhode Island	......	......	......	4,000	6.63	375.00	4,000	6.63	375.00	3,000	4.97	128.00	3,000	4.97	281.00	3,000	4.97	281.00
South Carolina	2,400	1.43	7.88	......	......	......	3,000	1.78	9.85	3,000	1.78	9.85	......	......	......	......	......	......
South Dakota	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	3,000	4.73	3.92
Tennessee	......	......	......	......	......	......	2,100	.90	5.04	3,000	1.29	7.20	3,000	1.29	7.20	3,500	1.50	8.40
Texas	2,750	.59	1.05	......	......	......	2,100	.45	.80	2,400	.51	.91	3,000	.64	1.14	4,800	1.02	1.82
Utah	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	2,400	5.34	2.92
Vermont	(1)	......	......	......	......	......	3,000	8.53	32.81	......	......	......	2,000	5.68	21.90	2,500	7.11	27.40
Virginia	3,500	1.52	8.68	......	......	......	......	......	......	2,750	1.19	6.83	2,500	1.08	6.20	4,000	1.73	9.93
Washington	3,000	2.21	4.49	3,600	2.65	5.39	3,000	2.21	4.49	......	......	......	......	......	......	3,000	2.21	4.49
West Virginia	2,700	1.85	11.22	2,700	1.85	11.22	2,700	1.85	11.22	2,400	1.64	9.98	1,800	1.23	7.99	3,600	2.46	14.99
Wisconsin	4,000	1.52	7.24	3,000	1.14	5.43	3,250	1.23	5.88	3,000	1.14	5.43	2,500	.95	4.53	3,600	1.37	6.51

[1] $10 per day. [2] Part time. [3] Paid by private organization. [4] Reduced from $6,000 in July, 1920.

titles of these divisions indicate the general activities undertaken. The exact scope of the work of each of the divisions is considered in detail in the Report of Chapin of which mention has already been made.

This will serve to illustrate the scope of service of a representative State Department of Health. The other states have departments organized along somewhat similiar lines. Many of these have more limited functions, smaller per capita appropriations and are, therefore, unable to carry on the necessary work in a satisfactory fashion. The per capita appropriations for public health purposes in the various states has been shown in Table XCII. In many instances the public health work done by the state departments is supplemented to a very considerable extent by the work of municipal health departments, as, for example, that executed by New York City Health Department and by other health departments in other large cities in New York.

In addition to the Federal and State health organizations there are in a large number of states county health organizations. The county as a unit for public health has been considered necessary where there are many small municipalities which manifest little interest or are financially unable to make provision for a proper public health service along purely local or municipal lines. County public health departments have been provided for by law within recent years in several states. In some of these the legislation is permissive, that is, in a given state counties may undertake to create a county public department if they wish to do so.

The object in these endeavors is to establish a unit smaller than the state, but still large enough to provide the necessary appropriation for the conduct of satisfactory public health work by the employment of full-time, technically trained health officers, public health nurses, sanitary engineers, etc. Even where such county units are organized, the state department continues to act in an advisory and supervisory capacity to these smaller units.

The last unit in the chain of public health organization is the municipal public health department and it is with this that the physician usually comes into the most intimate relationship. These local health departments were in many states conducting public health work before corresponding state health departments came

into existence. In many large communities also the standard of work has been very high and it has been quite unnecessary for state health departments to give much if any attention to these large city health departments. They are often provided with adequate appropriations, well staffed, and the administration is excellent.

Chapin has also shown that in the United States "there are four classes of communities which at present serve as local health units, which differ much in character and conditions though the first class merges gradually into the second. These classes are: (1) The larger cities with 50,000 inhabitants or over. (2) The smaller cities, towns and villages. (3) Townships. (4) Counties."

Chapin observes further "while the sanitation of our larger cities is far from perfect, it is far superior to what is found in the smaller municipalities where public health is usually sadly neglected. In the rural portions of the country conditions are still more unsatisfactory. While the death rate was reduced 21.1 per cent in the cities of the registration states from 1900 to 1912, in the rural sections of those states it was reduced only 8.6 per cent. Yet in 1910 over half the population of the United States lived in the country or in towns of less than 2,500 and the sanitary administration of most towns of 2,500 is wretched, while experience has shown that the larger cities can for the most part be left to care for themselves, the country and smaller towns, left to themselves, have with rare exceptions done little or nothing. It is now the general and well-founded belief that the sanitary progress of these communities must be stimulated, directed and perhaps controlled, by the state."

In a number of states, as for example Massachusetts and New York, the work of local health departments receives attention from health supervisors, officers of the state departments of health. These and other states are divided into districts, in each of which a sanitary supervisor is located. These district health officers endeavor not only to stimulate local interest, but they also carry on executive and administrative work under direction of the state department.

The most difficult problem in public health administration at present in both the United States and Canada is to evolve some plan whereby the smaller municipalities will obtain a better public health service than has hitherto been provided. While it is undoubtedly true that adequate appropriations would solve the problem, how is

it to be accomplished in States and Provinces where many local health officers receive no remuneration whatever, and where annual per capita expenditures for all public health purposes amount to 10 cents or less? In this connection data compiled for the American Public Health Association by Lee K. Frankel dealing with the number and percentage of health officers on part and full-time basis, etc., showing salaries paid, method of appointment, etc., should be consulted.

Physicians, public health nurses, and other public health workers should make it their duty to enlighten the general public in regard to what constitutes a minimum of public health effort, what such a service costs, and what may be accomplished.

In every community, rural or urban, constituting a local health unit (municipality) there should be provision for medical, nursing and dental service in the primary schools; there should likewise be provision for the searching out of cases of communicable diseases and institutional facilities for the care of those cases which cannot be treated at home. There should also be pure water and clean milk available for all, and foods offered for sale should be safeguarded. Registration of vital statistics should be regarded as a fundamental necessity. This is a bare outline of what should be thought of as absolutely essential. A health officer (even on a part-time basis) a public health nurse, on a full-time basis, and a sanitary inspector who may also devote a portion of his time to other work, is the third agent in the municipal organization the personnel of which is as limited as can be considered, if any work is to be done at all. In such rural communities (that is country districts, townships, villages, and towns of less than 5,000 population) about 25 cents per capita per annum is the smallest amount which should be expended for public health purposes. In towns over 5,000 population 70 cents per capita per annum would provide a reasonably satisfactory service and in cities of 10,000-20,000 population 75 cents may be sufficient. In larger cities 75 cents to $1.50 will probably be necessary. Armstrong has concluded from his experience up to the present in the Framingham Demonstration that $2.00 per capita per annum is necessary to provide an adequate municipal public health service, if both public and private funds are considered.

The actual proportion of the tax income in any municipality necessary to conduct health work varies greatly, of course, and depends

upon what is regarded as essential public health work. The cost of the care of the sick (mentally and physically) the destitute, and the unfortunate is largely, of course, not properly a public health charge, but is often so regarded. The support of hospitals if undertaken by the municipality for those suffering from other than communicable diseases should be provided for separately or at any rate shown separately in statements of expenditures.

The evolution of municipal public health organization is one of the most interesting social developments in the past seventy-five years. Chapin has indicated in his survey "Sixty years of the Providence Health Department" (organized July 7, 1856) the progress in the evolution of a representative city public health department. Organized originally to combat an epidemic of cholera, it rapidly extended its efforts to restrict the spread of other communicable diseases by the installation of methods for water purification and sewage disposal, and the general improvement of environmental conditions.

Next followed a period in which the control of smallpox through vaccination, scarlet fever and other contact diseases by isolation, disinfection etc., the prevention and treatment of diphtheria by the use of antitoxin and the hospitalization of many cases, was soon undertaken. The third phase has been characterized by determined efforts through public health education, the organization of public health clinics, and the building of sanitoria to cope with many other public health problems. This has been followed by the introduction of nursing and dental service, by efforts to reduce infant mortality, to control milk and other foods and provision has been made for laboratory service. Finally the entrance of the public health nurse into this field of endeavor, as an educational agent has been the most recent innovation.

The modern public health department in any city or town will be of the greatest service if it has the whole-hearted cooperation of the physician. For this reason every physician should be familiar with the public health machinery operating in his own community.

The municipal department of public health is usually responsible to the mayor or city council or is under the direction of a local board of health. The executive power of the board is or should be vested in the health officer. The board of health usually meets

about once a month when a report is presented by the health officer, giving an outline of the work done and a tabulated statement of births, marriages and deaths; often too a financial statement, and a brief summary of the work accomplished by each division of the department since the last meeting of the board. In addition a more comprehensive annual report along similiar lines is prepared.

Each year the members of the board appear before the municipal governing body (council or special committee) and with the local health officer, (by whom estimates have been prepared) request an appropriation sufficient for the proper conduct of the work of the department for the next ensuing year.

The following services are rendered to the general public and to physicians by a representative local health department:

1. Control of communicable diseases by: supervising isolation, quarantine, placarding, etc., maintenance of isolation hospital, distribution of antitoxin, sera and vaccines.
2. Provision of Laboratory diagnostic service.
3. Control of water supplies—supervision of sewerage system.
4. Providing Public Health Nursing and Social Service.
5. Providing Medical, Dental and Nursing Service in schools.
6. Food (including milk and meat) control, through licensing, inspection and supervision.
7. Tabulation and publication of vital statistics, morbidity reports, etc., and by public health education and publicity.
8. Providing a sanitation service for abatement of nuisances, and a division of industrial hygiene for the supervision of industrial establishments.
9. Conducting Public Health Clinics for venereal diseases, maternal, infant and child hygiene, tuberculosis, mental abnormalities and subnormalities, etc.

In order to make due provision for the various features of the work of such a modern city health department, to insure that the various activities may receive the appropriate degree of attention and effort, tabulations showing the relative values of health work have been prepared. The most recent of these suggested by Chapin is shown in Table XCIII.

A somewhat different proposal made by Oleson provides, in the form of a score card, for arriving at the efficiency of local health departments, by assigning certain more or less arbitrary values to

TABLE XCIII

RELATIVE VALUES OF HEALTH WORK (CHAPIN)

Vital Statistics		60
Education		80
Laboratory		50
Control of nostrums		50
Care of the sick poor		50
Food	Adulteration	0
	Sanitation	10
Milk	Adulteration	3
	Sanitation	17
Nuisances	Privy sanitation	60
	Housing	20
	Plumbing	10
	Nuisances	10
	Refuse removal	0
	Fly and mosquito control	10
Infant Mortality	Nurses	80
	Supervision of midwives	10
	Babies' boarding houses	5
	Milk stations	5
	Consultations	20
	Prenatal clinics	10
School inspection		80
Contagious Diseases	Home isolation	100
	Hospitalization	50
	Immunization	50
	Venereal diseases	20
Tuberculosis	Nurses	60
	Dispensaries	40
	Hospitalization	40
		1,000

the different activities and to the equipment of the departments. These are shown in Table XCIV.

Many studies of municipal public health organizations in the United States have been made by officers of the United States Public Health Service. The following reprints from the Public Health Reports, United States Public Health Service, are among those dealing with this subject: Numbers 300, 365, 201, 284, 417, 427, 439.

According to Broadhurst, local public health organizations have been found by the Russell Sage Foundation to cost from three-quarters of a cent per capita to 98 cents. The City of New York, according to the same author, spends 58 cents per capita.

TABLE XCIV

SHOWING THE EFFICIENCY OF THE HEALTH OFFICERS

ACTIVITIES

CHARACTER OF ACTIVITY	SCORE OF POINTS PERFECT	SCORE OF POINTS ALLOWED
(1) Communicable diseases; suppression and prevention	18	....
(2) Laboratory diagnosis, collection and transmission of specimens for diagnosis and investigation. Distribution of antitoxins and serums	10	....
(3) Education of public, exhibits, lectures, circulars newspaper articles, etc.	8	....
(4) Vital statistics	7	....
(5) Co-ordination of extraneous health agencies	6	....
(6) Concurrent disinfection	6	....
(7) Infant and maternal welfare work	6	....
(8) Public health nursing	5	....
(9) Control of water supplies	4	....
(10) Inspection and control of milk supplies	4	....
(11) Occupational diseases, prevention and control	4	....
(12) Medical inspection of school children and correction of defects	4	....
(13) Mental hygiene	3	....
(14) Control of such preventable diseases as heart and kidney diseases, etc.	3	....
(15) Clerical work, correspondence, records and reports	3	....
(16) Sewage disposal	3	....
(17) Attendance at conferences, board of health meetings	3	....
(18) Food and meat inspection and control of slaughter houses, butcher shops and grocery stores	1	....
(19) Inspection of public buildings	1	....
(20) Terminal fumigation	½	....
(21) Investigation and abatement of nuisances	½	....
TOTAL	100	....

EQUIPMENT

NATURE OF EQUIPMENT	SCORE IN POINTS PERFECT	SCORE IN POINTS ALLOWED
(1) Telephone	20	....
(2) Transportation	17	....
(3) Clerk	12	....
(4) Office	10	....
(5) Report cards (a) from physicians	5	....
(b) to state boards of health	5	....
(6) Quarantine cards (placards)	8	....
(7) Vaccine and antitoxin or facilities for obtaining same	7	....
(8) Record books for filing cases	6	....
(9) Literature for self-education and reference	5	....
(10) Literature for distribution	4	....
(11) Fumigants or facilities for obtaining same	1	....
TOTAL	100	....

PUBLIC HEALTH ORGANIZATION IN CANADA

Historical.—The early history of organized public health work in Canada is similar to that in the United States. The first public health legislation enacted in Canada apparently was in 1794 when a Quarantine Act was passed. There seems to have been little or no machinery created to carry out the purpose of the Act and there followed a long period until 1833 before further activities were contemplated. In that year, spurred on by the appearance of cholera in epidemic form in many parts of the world, an Act was passed by the Legislature of Upper Canada entitled an "Act to Establish Boards of Health."

This was permissive legislation and, as the epidemic of cholera subsided in 1834, nothing further was done. Until the year 1848 owing to the absence of the usual incentive of the times, namely, a serious epidemic of some communicable disease, there is no evidence that the inhabitants of Upper and Lower Canada (the Provinces having been united by the Act of Union of 1840) deemed it essential to have some central public health authority. However, typhus fever which raged in many countries in 1845-47, and cholera having again become epidemic in 1849, apparently gave rise to considerable concern and in that year there was passed an Act by the Parliament of Upper and Lower Canada to establish a "Central Board of Health." (This was an amendment to Act V of William IV.)

Cholera, however, did not cause any serious ravages in Canada at the time, nor did typhus fever except among immigrants who were suffering from the disease on arrival in the country (in 1847, 98,106 immigrants passed through the Port of Quebec; of these 8,691 were admitted to the Immigration Hospital at Grosse Isle, Quebec, and 3,226 died there of typhus fever; in addition 2,198 died on ships held in quarantine); therefore only the necessary amount of quarantine work seems to have been carried on. Another serious epidemic of cholera broke out in 1866 and new regulations were gazetted under existing laws. The Confederation of the Canadian Provinces was arranged and consummated in the passage of the British North America Act in 1867. This measure left all matters pertaining to public health to be dealt with by the Provincial legislatures, except those of mutual concern such as international and

interprovincial quarantine, the care of mariners, the control of lepers, etc.

From this time, therefore, the history of public health development in Canada follows along Federal and Provincial lines. The subsequent developments in the Federal field may, therefore, be first considered. Between 1867 and 1919 there were several departments of the Federal Government charged with the duty of administering certain public health activities. These were the Departments of Agriculture, of Immigration, Marine and Fisheries, Public Works, etc. These various departments among them provided for the maintenance of international and interprovincial quarantine, the medical inspection of immigrants, the care of lepers, the hospital care of seamen on ships engaged in maritime commerce other than on the Great Lakes and in the Province of Ontario, the enforcement of provisions of the Adulteration Act (relating to foods) the Proprietary or Patent Medicine Act; and the supervision of persons employed in public works under control of the Parliament of Canada. The most important work carried on under this system had to do with maritime quarantine, the inspection of immigrants, the care of disabled seamen and the control of foods and drugs, in the Central Food and Drugs Laboratory, established in Ottawa in 1884. It was realized for many years that the administration of national public health work in Canada would be more effectively conducted if coordinated under one Minister of the Crown in a single department of government. Furthermore the creation of such a Ministry of Health would be in line with what has been done or was contemplated in England and in other British Dominions; accordingly in June, 1919, the Department (Ministry) of Health, Canada was created under the following:

Whereas it is expedient, for the preservation of the health and the promotion of the social welfare of the people of Canada, that a Department of Health be established in the Dominion: Therefore His Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows: Preamble

1. This Act may be cited as The Department of Health Act. Short title

2. There shall be a Department of the Government of Canada which shall be called "The Department of Health," over which a Minister of the Crown to be named by the Governor in Council shall preside. Department

3. (1) The Governor in Council may appoint an Officer, who shall be called "the Deputy Minister of Health," who shall be the deputy head of the Department and who shall hold office during pleasure. Deputy Minister

(2) Such other officers, clerks, and employees as are necessary for the proper conduct of the business of the Department may be appointed in accordance with the provisions of The Civil Service Act, 1918, and of any Acts in amendment thereof, all of whom shall hold office during pleasure. Staff

(3) The Governor in Council may, subject to provisions of the Civil Service Act, 1918, or any amendment thereto, transfer to the Department of Health any officer, clerk or employee now in the employ of His Majesty or of either or both Houses of Parliament, and subsection two of section seventeen of the said Act shall not apply to such transfers, and the money voted by Parliament for the financial year ending the thirty-first day of March, one thousand nine hundred and twenty, applicable to the payment of the salary or the increase of salary of any such officer, clerk or employee so transferred shall be available for the payment of his salary or increase of salary or the salary of any person appointed in his place in case of his death, retirement or dismissal while serving in the Department of Health, in the same manner and to the same extent as if such officer, clerk or employee had not been so transferred. Transfer of officers to Dept. of Health. Age Limit

4. The duties and powers of the Minister administering the Department of Health shall extend to and include all matters and questions relating to the promotion or preservation of the health of the people of Canada over which the Parliament of Canada has jurisdiction; and, without restricting the generality of the foregoing, particularly the following matters and subjects: Duties and powers of Minister

(a) Cooperation with the provincial, territorial, and other health authorities with a view to the coordination of the efforts proposed or made for preserving and improving the public health, the conservation of child life and the promotion of child welfare;

(b) The establishment and maintenance of a national laboratory for public health and research work;

(c) The inspection and medical care of immigrants and seamen, and the administration of Marine Hospitals;

(d) The supervision, as regards the public health, of railways, boats, ships and all methods of transportation.

(e) The supervision of Federal public buildings and offices with a review to conserving and promoting the health of the Civil Servants and other Government employees therein;

(f) The enforcement of any rules or regulations made by the International Joint Commission, promulgated pursuant to the treaty between the United States of America and His Majesty relating to boundary waters and questions arising between the United States of America and Canada, so far as the same relate to public health;

(g) The administration of the statutes mentioned in the Schedule of this Act, and of Acts amending the same, and also of all orders and regulations passed or made under any of the said Acts; and all the duties and powers of any Minister of the Crown under either of the said Acts of any of the said orders or regulations, are hereby transferred to and conferred upon the Minister of Health;

(h) Subject to the provision of The Statistics Act, the collection, publication and distribution of information relating to thé public health, improved santitation and the social and industrial conditions affecting the health and lives of the people;

(i) Such other matters relating to health as may be referred to the Department by the Governor in Council.

5. The Governor in Council shall have power to make such regulations as may be necessary to give effect to and carry out the objects of this Act, and to impose penalties for any violation of such regulations. **Regulations.**

6. There shall be a Dominion Council of Health consisting of the Deputy Minister of Health, who shall be chairman, the chief executive officer of the Provincial Department or Board of Health of each Province, and such other persons, not to exceed five in number, as may be appointed by the Governor in Council, who shall hold office for three years. The Dominion Council shall meet at such times and places as the Minister may direct, and shall be charged with such duties and powers in respect to this Act as the Governor in council may prescribe.

7. Nothing in this Act or in any regulation made thereunder shall authorize the Minister or any officer of the Department to exercise any jurisdiction or control over any Provincial or Municipal Board of Health or other health authority operating under the laws of any province.

8. The Minister shall annually lay before Parliament within fifteen days after the meeting thereof, a report and statement of the transactions and affairs of the Department during the year preceding.

SCHEDULE.

Revised Statutes of Canada — 1906	CHAPTER
The Quarantine Act	74
The Adulteration Act	133
The Public Works Health Act	135
The leprosy Act	136
The Canadian Shipping Act, sections 406, 407 and 408	113
STATUTES OF 1908.	
The Proprietary or Patent Medicines Act	56

The Acts in amendment of any of the foregoing Acts.

The first Annual Report of the Department of Health, Canada, for the year ended March, 1920, contains a summary of the organization, scope of work, appropriations, etc., of this Department. The Department is in charge of a Deputy Minister responsible to the Cabinet Minister who is also at present responsible for the administration of certain other departments of government. The legislative functions of the Ministry are details in the Acts given in the Schedule of the Act creating the Department. The executive functions are performed through administrative divisions and deal with the following:

1. Quarantine Service,
2. Immigration Medical Service,
3. Food and Drug Laboratories,
4. Opium and Narcotic Drugs,
5. Proprietary or patent medicines,
6. Marine Hospitals' Service,
7. Venereal Diseases Control,
8. Publicity and Statistics,
9. Child Welfare,
10. Housing.

In connection with the Quarantine Service, Stations (with hospitals in certain instances) are maintained at Halifax, North Sydney and Louisburg, Nova Scotia; Chatham and St. John, New Brunswick; Charlottown, Prince Edward Island; William Head, Victoria, British Columbia. During the year 1918-19 at these stations, 1450 vessels were inspected and 277,910 persons examined. The conditions for which admission to quarantine hospitals was required were, smallpox, diphtheria, measles, influenza, scarlet fever, pneumonia, mumps, etc. No case of major communicable diseases such

as Asiatic cholera, typhus fever, plague, sought admission during that year. Leper lazarettos are conducted at Tracadie, N. B., and D'Arcy Island, B. C. In all 19 lepers were under treatment during the year.

Under the Public Health Works Health Act, sanitary supervision of the camps, etc., of men engaged in Dominion of Canada public works, was maintained. Medical inspection of immigrants carried on in Quebec, St. John, N. B., Halifax, New York, Boston and Portland, North Sydney and Vancouver and Victoria resulted during 1919-20 in 67,680 persons coming under observation of medical officers of this division of the Service. The purpose of the inspection is to exclude persons who are physically or mentally unfit and likely to become public charges. The medical side of the work only is done by this division; all other aspects of immigration work are conducted by the Department of Immigration and Colonization. Immigrants entering the Dominion of Canada may be passed or they may be classified as "detentions" or "rejections." The former numbered 152 and the latter 21, during the year 1919-20 among a total of 67,680 applying for admission. In addition 85 persons were deported for medical causes after admission to Canada at ocean ports.

The Food and Drug Laboratory is organized for conduct of routine examinations of foods and drugs. There is a central laboratory in Ottawa, and sublaboratories in Halifax, Winnipeg and Vancouver, and a fourth is to be established in Montreal.

The administration of the Opium and Narcotic Drug Act and the Proprietary or Patent Medicines Act is the work of another division of the Federal Department of Health.

The Marine Hospitals Service under provisions of the Canada Shipping Act., Part V, is enabled through dues levied on vessels entering any port in the Provinces of Quebec, New Brunswick, Nova Scotia, Prince Edward Island and British Columbia, to provide gratuitous treatment for sick and distressed mariners belonging to vessels on which dues have been paid. Hospitals in various cities in the above Provinces are utilized for the purpose of providing the necessary care and treatment of those in need of it. During 1919-20, 2,552 seamen were treated; the total number of treatment days was 27,784 and the expenditure for the purpose $88,886.36.

Under the division of Venereal Disease Control, \$200,000 a year is voted for combating these diseases in cooperation with the provinces, the grants being made on condition that equivalent sums of money were voted by the Provincial Legislatures for the same purpose. It was agreed further that the total amount available for distribution should be divided in proportion to population. At the same time a grant from the original amount voted was made to the Canadian National Council for Combating Venereal Diseases and 5 per cent was retained for administration. The following agreement was entered into with the Provinces accepting the grant.

1. "Establishments of clinics with specialist physicians in charge of treatment: with sufficient assistants to carry on the work efficiently and gratis to the patients."

2. "Hospital beds for indoor patients; all treatments gratis."

3. "Diagnostic laboratories for venereal disease work."

4. "Efficient treatment for inmates of jails and places of detention."

5. "A specialist in venereal disease diagnosis, treatment and propaganda to carry out the venereal disease work of the provinces."

Grants were made as follows for the first six months' period:

Alberta	\$ 5,989.81
Ontario	28,736.84
Nova Scotia	5,286.93
Saskatchewan	7,680.82
Manitoba	6,305.60
New Brunswick	3,758.92
British Columbia	7,314.10
Quebec	23,694.40
National Council for combating V. D.	5,000.00
TOTAL	\$93,767.42

The other administrative divisions of the Department are those of Publicity and Statistics, which carry on active work in the dissemination of public health information and statistics; Child Welfare through which educational work is done in that field; and Housing.

Table XCV is a statement of appropriations of the Department of Health Canada for the fiscal year 1919-20.

As already indicated, a very large part of public health work in

TABLE XCV

STATEMENT OF APPROPRIATION ACCOUNTS FOR FISCAL YEAR 1919-20

NO. OF VOTE	SERVICE	APPROPRIATION	EXPENDITURE	BALANCE UNEXPENDED
54	Quarantine, lazarettos and Public Works Health Act	$241,000.00	$222,505.78	$ 18,494.22
330	Adulteration of food, etc.	70,000.00	42,001.77	27,998.23
330	Proprietary or patent medicines	3,000.00	2,985.42	14.58
418	Salary of deputy minister	6,000.00	4,290.32	1,709.68
418	*Salaries of staff and contingencies	60,000.00	26,802.54	33,197.46
225) 498)	Marine hospitals	97,500.00	88,886.36	8,613.64
War	Housing (from Nov.1, 1919)	8,000.00	6,022.29	1,977.71
522	For combating venereal diseases	200,000.00	93,767.42	106,232.58
		$685,500.00	$487,261.90	$198,238.10

*The officials transferred to the Department of Health, paid from Civil Government Salaries, were paid by the department from which they were transferred to March 31, 1920.

Canada was left to the individual provinces. In consequence there has been created in each province a Provincial Board of Health, or Bureau of Public Health. In the Province of New Brunswick, a Department of Public Health with a Minister of the Government in charge was created in 1918, and this was one of the first departments of public health under a separate minister to be established anywhere. In the Province of Alberta there is also a Department of Health. In Saskatchewan the Bureau of Public Health is under the Minister of Municipal Affairs; in Ontario it is in the Department of Labor and Health; in the other Provinces the Provincial Board of Health is in a Department of the Provincial Government charged with various other administrative duties.

In the Province of Ontario which at present expends a larger per capita amount on public health than any other Canadian Province, a Provincial Board of Health was established in 1882 (under Chapter 29, R. S. O. 190, 45 Victoria).

In 1884 a Public Health Act was passed by the Legislature which was the basis of public health law in the Province of Ontario as it exists today. Under this original Act a Provincial Board of Health of seven members was created and provision was made for the appointment of an executive officer first designated the Secretary of the Board and later the Chief Officer of Health and Secretary of the Provincial Board of Health.

The Provincial Public Health organization created by the first Public Health Act had as its functions:

1. The collection of sanitary information.
2. The dissemination of sanitary information.
3. The promotion of public health legislation.
4. Investigation into causes of diseases.
5. Dealing with outbreaks of communicable diseases.
6. Control of water supplies and certain foods such as milk.
7. Promotion of school hygiene.
8. Supervision of sanitary conditions in public institutions.

At first owing to limited appropriations and personnel it was possible to do little more than attempt to control outbreaks of diseases, especially smallpox, recommend the installation of communal systems for the supply of water, disposal of sewage, etc., and the abatement of nuisances. Owing to the fact that the public health legislation enacted was of a very advanced character and because of the excellence of administration (under the direction of a pioneer in Canadian public health work Dr. P. H. Bryce of Ottawa) much valuable work was done.

Under the Act all Municipalities in the Province were required to set up Local Boards of Health, and these were assisted in their efforts to improve sanitary conditions throughout the Province. In 1882, there were, for example, 12 municipalities, cities and towns, villages, etc., (among nearly 600) having public water supplies and 7 with sewerage systems. By 1901 there were 110 municipalities providing public water supplies and 48 with sewerage systems. In 1920, these numbered 175 and 130 respectively.

Improvements in the Public Health Act were made from time to time. Among the important changes were those providing for the creation of the position of Chief Officer of Health in 1887; provision whereby land might be appropriated as a site for an isolation hospital; provision for inspection of dairies, abattoirs, etc., and for the supervision of milk and meat supplies offered for sale; providing that the plans for installation of municipal systems of water supplies or sewerage must be first approved by the Provincial Board of Health before the work was undertaken; provision for licensing and inspecting sources of milk and meat supplies; creation of a provincial diagnostic laboratory in 1890; provision for the supervision

of sanitation in unorganized territory; for notification of communicable diseases, etc.

In 1912 there was a complete revision of the Public Health Act and the Vaccination Act. The Province under this was divided into 10 Sanitary Districts (the cities of 50,000 population and upwards were not included in these Districts) in each of which it was provided, there should be a District Officer of Health who would, under the direction of the Provincial Board of Health, supervise public health and sanitation, especially in the smaller municipalities (cities of less than 50,000 population, towns, villages and townships; all of which have local boards of health to the number of about 700 at present).

In addition the amended act provided for permanency of tenancy of office of the local Medical Officer of Health because while he is engaged by the local municipality, he can only be dismissed with the approval of the Provincial Board of Health. An annual Conference of all local Medical Officers of Health was also arranged for, and it was stipulated that the municipality should bear the expenses of the Medical Officer of Health in attending the conference.

Subsequent less important amendments have been made to the Act which is at present known as the Public Health Act (Chap. 218 R. S. O. 1914). In addition to the administration of the Act, supervising local boards of health, approving plans for the installation of water supplies and sewerage systems, providing a public health diagnostic laboratory service, dealing with outbreaks of communicable disease and publishing data in reference to the incidence of communicable diseases and providing for public health education and publicity, the provincial board of health began to stimulate interest in infant and child hygiene and in 1916 began the free distribution of all public health biological products (diphtheria and tetanus antitoxin, antimeningitis serum, smallpox vaccine, antirabic vaccine, antityphoid and pertussis vaccines, silver nitrate solution for the prevention of ophthalmia neonatorum, etc.) to the local boards of health, isolation hospitals, etc., and through these they are distributed to all physicians throughout the province. This service has been developed in cooperation with the Connaught Antitoxin Laboratories in the University of Toronto. These laboratories prepare the products and the Provincial Board of Health purchases

them at approximately cost of production and distributes them gratuitously as indicated.

The present functions of the Provincial Board of Health of Ontario, judicial (or quasi-judicial), and legislative are authorized by the Public Health Act, (and regulations promulgated thereunder) the Vaccination Act, the Vital Statistics Act and the Venereal Diseases Prevention Act. The executive work is directed by the Chief Officer of Health in cooperation with the Provincial Board of Health which meets quarterly (the Chief Officer possesses all the executive powers of the Board in the intervals between meetings).

The Chief Officer is responsible to the Minister of Labor and Health who is a member of the Government. The Chief Officer is also Deputy Registrar-General.

The executive work is done through administrative divisions, of which there are nine each with a director and staff, and through the district officers and the public health nurses (these latter work in the field throughout the Province). The character of this organization, the population of the Province and the provincial public health appropriations for 1920 are shown in Fig. 123.

The work of these divisions is briefly as follows:

(a) **Public Health Administration.**—The executive direction of all work, the promotion of sanitary legislation, the preparation of estimates, correlation of work of all divisions; the collection, tabulation and publication of morbidity statistics as they relate to communicable diseases. Through the activities of the Chief Officer of Health, the head of this division, public health appropriations in this Province have grown from $50,000 in 1910 to $527,000 in 1920.

(b) **Laboratories.**—Provision of diagnostic laboratory service at the main laboratories in Toronto and in the branch laboratories in London, Kingston, Fort William, North Bay, Sault Ste. Marie, Peterboro' and Owen Sound. In these laboratories specimens such as sputa from suspected cases of tuberculosis, blood from suspected cases of typhoid fever (Widal reaction), throat swabs from suspected cases of diphtheria, blood from suspected cases of syphilis (Wassermann test), smears from suspected cases of gonorrhea, and samples of water, milk or other foods, etc., are examined without cost for physicians. In addition this division distributes public health biological products as outlined above.

PUBLIC HEALTH ORGANIZATION

PROVINCE OF ONTARIO

Minister of Labor and Health

Chief Officer of Health

Provincial Board of Health (7 members)

Consultants in;—
(1) Public Health Administration.
(2) Child Welfare.
(3) Obstetrics.

DIVISIONS:
(1) Public health administration,
(2) Laboratories,
(3) Sanitary engineering,
(4) Maternal and child welfare and Public health nursing.
(5) Public health education
(6) Venereal diseases,
(7) Industrial hygiene,
(8) Vital statistics (Registrar-General's Branch)

8 District Health Officers.
16 Public Health Nurses.

Appropriation—1920 .... $527,626.80
(Being about 1/34 of the revenue of the Province and about 18c per capita)
Estimated Population of Ontario—2,900,000.

Fig. 123.

(c) **Sanitary Engineering.**—This division examines plans of proposed municipal systems of water supplies and sewerage systems. Also an experimental plant laboratory is conducted where the efficacy, etc., of proposed sanitary engineering installations or new methods may be ascertained. In addition active promotion of increased interest in general sanitary conditions in municipalities is carried on and a free advisory service provided for municipalities contemplating undertaking sanitary engineering works. The usefulness of a division of this kind is strongly reflected in the reduced typhoid death rate obtaining in Ontario cities. The present city

typhoid death rate in Ontario is 4.3 per 100,000 of population, and that of rural communities 4.5 per 100,000 and the average rate for the Province 5.2, which is much lower than in any other Canadian Province or in the United States (McCullough—*A Decade of Public Health Progress*).

(d) **Maternal and Child Welfare; and Public Health Nursing.**—This division endeavors to stimulate municipalities to develop work in the antenatal and infant and child hygiene fields. By demonstrations, through the work of public health nurses, and that of the "Child Welfare Special" (a mobile Baby Welfare Clinic) with its pediatrician and nurses there are established local antenatal and "well-baby" clinics. This is one of the most important types of work undertaken and has been referred to elsewhere.

(e) **Public Health Education.**—Conducts a vigorous and energetic campaign of publicity and public health education in the province by means of popular articles in newspapers; by public health exhibits, educational motion pictures, lectures, etc.

(f) **Venereal Diseases.**—This division is charged with conduct of the antivenereal diseases campaign in cooperation with the Federal Department of Health as already outlined. Municipalities are encouraged to organize venereal disease clinics (there are thirteen such clinics in the province at present); to these a grant of $1,000 is made to obtain equipment, thereafter grants are made to assist in the payment of the specialist in charge of the clinic, also the public health nurse or social worker attached thereto. In addition a per diem grant is made to these clinics for each patient treated. The treatment of all inmates of provincial institutions or places of detention is also carried out. Vigorous publicity and educational work is done; sources of infection searched out by a public health nurse attached to the division; enforcement of the Venereal Disease Prevention Act and supervision and the treatment of persons in remote rural communities far from clinic centers provided for. In addition free diagnostic laboratory service for the examination of blood for the Wassermann reaction, smears for gonococci, etc., is provided in the eight laboratories serving the various sections of the province.

(g) **Industrial Hygiene.**—This division is concerned with the improvement of health and environmental conditions of industrial

workers. Investigations, education and preparation of standards are directions in which this work is vigorously prosecuted.

(h) **Vital Statistics.**—(Registrar-General's Branch.) The tabulation, classification and publication of data relating to births, marriages and deaths and causes of deaths is one of the most important and essential branches of public health work, and in Ontario is carried out in this division.

The district officers of health working in the field, supervise the enforcement of the provisions of the Public Health Act, and actively engage in the work of health promotion in their respective districts without in any way conflicting with the local public health authorities. The public health nurses work under the immediate direction of the head of the division of maternal and child welfare and public health nursing. They do general public health educational work as well as the work in their special field in communities not already provided with public health nurses in an endeavor to stimulate these communities to engage such. An interesting account of the development of public health in Ontario is contained in McCullough's *A Decade of Public Health Progress.*

The Provincial Government assists in the campaign against tuberculosis by providing an amount up to $4,000 towards the cost of building a sanatorium and makes a grant of $3.50 per week towards the cost of maintenance of patients admitted to these institutions. Sanatorium and preventorium accommodation in Ontario now amounts to about 2,000 beds. Other public health work conducted by the Government of Ontario is that of assisting and encouraging the establishment of local medical, dental and nursing service in primary schools. This work is conducted by the Provincial Department of Education and is for the purpose outlined in the article in the appendix devoted to this topic.

The general scope of public health work in nearly all the other Canadian Provinces is somewhat similar to that in Ontario, the extent of the work being less extensive in all the others, because of smaller appropriations for provincial public health expenditures.

Municipal Public Health Organization.—In Ontario and in practically all other provinces with the exception of New Brunswick and Prince Edward Island there are in all organized municipalities, local boards of health or municipal departments of health. These are organized, their duties defined and their relationship to the provin-

cial public health organization, laid down under the various public health acts of the different Provinces.

In every case there is a local board of health consisting usually of the executive officer of the board, i.e., the medical officer of health, the mayor, and a certain number (one or three) of the rate payers resident in the municipality and a secretary who is frequently in addition, the clerk of the municipality.

The scope of work of the local boards of health varies greatly depending upon the population of the municipalities and upon the extent of the public health appropriations. In a general way, the larger cities, those of 50,000 population and upwards, have extensive organizations with full-time officers of health, and an adequate personnel. The cities of from 10,000 to 50,000 are usually less well organized and communities of less than 5,000 population including smaller towns, villages and townships or rural municipalities have frequently only a skeleton organization and do a very meager amount of work because of very inadequate appropriations for public health activities.

In a very interesting study of municipal public health expenditures in the Province of Ontario, Wodehouse has recorded the result of an investigation into:

(a) The total public health expenditure of each municipality.

(b) The proportion of the tax-income which expenditure under (a) represents.

(c) The per capita expenditure on public health.

(d) The taxation per capita.

(e) Municipalities which did not make any appropriations for public health purposes.

(f) Municipalities which did not in 1919 remunerate the medical officer of health.

(g) The salaries of medical officers of health who were paid.

(h) The per capita cost to the residents of the municipality of the salary of the M. O. H.

This investigation revealed the fact that three cities in the Province spent in 1919 more than $1.00 per capita on public health. The other cities, 21 in number, expended during 1919, 44 cents per capita. Twenty-two municipalities with a population over 5,000 and less than 10,000 expended about 26 cents per capita; while 805 municipalities

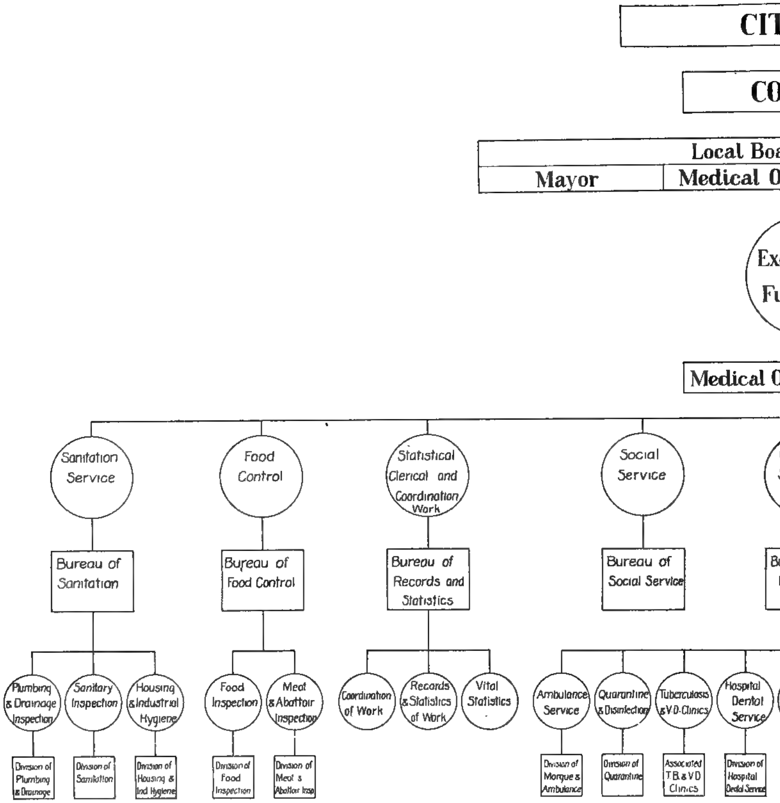


Fig. 124.—Organization Chart, Department of Public Health, Toronto, Canada.

constituting $\frac{8}{15}$ of the total population of the Province and composed of 114 towns (of less than 5,000 population), 147 villages and 544 townships, spent only about 10 cents per capita for public health purposes. This is shown in Table XCVI prepared by Wodehouse, and it also indicates population data and recommendations as to appropriate public health expenditures.

In those municipalities in which very little public health work is at present undertaken, much more will be done in the future when the general public comes to realize that there is a direct relationship between the expenditures for public health and the death rate and volume of sickness and disability arising in any community.

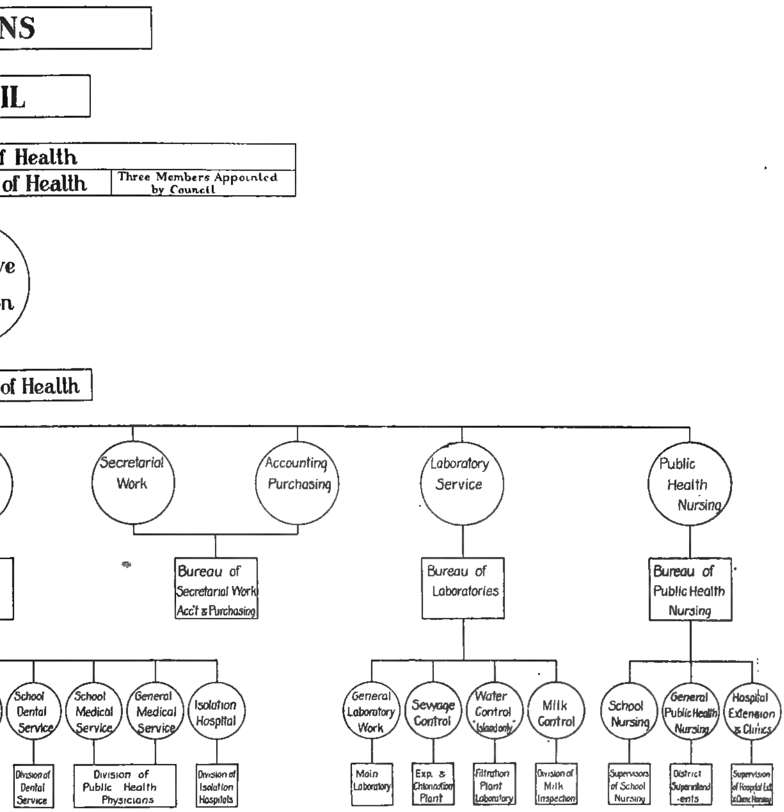


Fig. 124.—See opposite page for legend.

In the city of Toronto certain comparisons are possible as a result of data furnished by the Division of Records and Statistics and Table XCVII contrasts 1909 with 1919 with respect to certain important points.

The organization of the Department of Public Health of Toronto is shown in Fig.124.

The executive work is carried out through the Divisions shown in the diagram and the character of the work done by each of these is indicated in general terms by the several designations. In addition to the work of general administration, provision of medical, dental and quarantine services, public health nursing, school health supervi-

TABLE XCVI

PROVINCIAL AND MUNICIPAL PUBLIC HEALTH EXPENDITURES IN ONTARIO—1919 (WODEHOUSE)

							Recommended	
	Population	Province fraction of	Income tax	Fraction of income spent for public health	Health expenditure aggregate	Health expenditure per head population per year	Fraction of income for health expenditure	Health expenditure per head population
Province of Ontario	2,599,950	1/1	$19,000,000	1/34	$528,000	$0.20	....	....
City of Toronto	489,681	1/5	20,234,656	1/34	600,180	1.23	1/34	$1.25
Cities other than Toronto	609,706	1/5+	23,585,382	1/88	269,087	0.44	1/45	0.70
Towns over 5,000 population	155,622	1/5−	2,695,756	1/67	40,244	0.26	1/45	0.70
Rural	1,334,941	8/15+	21,567,297	1/163	137,927	0.10	1/66	0.25

TABLE XCVII

CITY OF TORONTO

	1909	1919
Crude death-rate	15.3	11.4
Infant death-rate	182.2	101.1
Typhoid death-rate	24.7 (40.8 in 1910)	2.6
Tuberculosis death-rate	102	61
No. of public health nurses	1	95
No. of child welfare clinics	0	23
Population	311,354	499,278
Expenditure	$84,750.00	$593,871.00
Per capita expenditure	.27	1.18

sion, social service and cooperative work, laboratory service (including supervision of water and milk supplies), isolation hospital service, records and statistics, food control, sanitation service, there are conducted independently, or in cooperation with hospitals, or other agencies—"well-baby" (infant and child hygiene) clinics, antenatal clinics, venereal disease clinics, tuberculosis clinics, psychopathic clinics, etc.

In smaller cities the organization is much more limited. Table XCVIII shows the actual organization in a city of about 23,000 pop-

TABLE XCVIII

Population — 23,027		Tax Rate 30.50 Mills
Total Taxable Assessment —	$14,750,388.00	
Total Revenue	497,564.76	
Public Health Expenditure:		
Board of Health (Provided in 1920 estimates)		$6,000.00
Board of Education, school nurse		900.00
Grant to Victorian Order Nurse		500.00
Sanitary Inspector		1,100.00
		$8,500.00
1/65 of total Revenue, 33c a head of population		
Itemized Board of Health Expenditure		
M. O. H. Salary		$1,000.00
Secretary Board of Health		100.00
Maintenance		4,900.00
		$6,000.00
Proper Public Health Organization & Budget for this City;—		
M. O. H. (10c a head)	$1,000.	$1,300.
Sanitary Inspector	1,200.	
Health Nurse	1,500.	
Part-time Clerk	600.	
Epidemiology (Lab. $1,000)	7,150.	1,000.
School Nurse	1,200.	
Health Center	1,000.	1,000.
	$13,650	

ulation. To this has been added a recommended organization and suggested suitable appropriation for this municipality.

In smaller municipalities—those with a population of 5,000 to 10,000—almost the same type of organization is desirable but will seldom be provided at the present time. In rural municipalities, towns of less than 5,000, villages and townships there should be a part-time health officer paid a salary determined by the population of the municipality served, on a basis of 10 cents per capita. In addition a public health nurse on a full-time basis should be engaged, and a part-time sanitary inspector.

The medical officer of health is responsible to the local board of health of which he is a member. The board will probably meet quarterly and the medical officer of health at other times is responsible for the conduct of the work. The medical officer of health is paid by the council of the municipality. In Ontario if he is not satisfied with the remuneration which he receives he may ask a judge of the County Court to fix his stipend. The medical officer of health

should have some place such as an office where records and statistics may be kept and where any other persons working under his directions may consult him when occasion arises.

Careful records of births and deaths in the municipality should be available; also a record of cases of communicable diseases. The abatement of nuisances, inspection of slaughter houses, etc., should be left to the sanitary inspector. The medical officer of health should interest himself in the big problems of health promotion and disease prevention and at the earliest possible moment see to it that his municipality has supervision of water and milk and other food supplies; has health supervision in all primary schools, conducts public health educational work, has at least the part-time service of a public health nurse to assist in the control of antenatal and child hygiene and other public health clinics or health centers which should be established in every municipality and supported if necessary by the joint effort of the municipality and a local voluntary committee or organization.

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CHAPTER XXV

PUBLIC HEALTH EDUCATION AND VOLUNTARY HEALTH PROMOTING AGENCIES

It has long been recognized that the widespread dissemination of information regarding health, both personal and public, is very important and absolutely essential if any improvement in the condition of the health of the people is to be effected. First steps taken in health education were in the direction of improving or maintaining the health of the individual; that is, the subject was considered chiefly if not solely from the point of view of personal hygiene. From very early times down to the present, precepts and even special regulations devised for the purpose of indicating how personal health might be enjoyed, have been available for those who sought them, on the one hand, and required among those of certain sects on the other.

Never until comparatively recently, however, have systematized and organized efforts been made to utilize all known methods of education and publicity to convey the essential facts of personal hygiene and public health to great masses of the people, in every civilized community.

Educators, as well as those particularly interested in public health progress and sanitary reform, realized the very vital bearing of this and were among the first to take steps to promote the teaching of the essentials of healthy living. Then, too, early in the development of organized public health work this subject was deemed to be so important that it was specifically mentioned as one of the objects for which boards of health were created. For example, the original public machinery set up in 1882 in the Province of Ontario had as its second purpose the "dissemination of sanitary information."

However, forty or fifty years ago the funds available in the appropriations of departments of health, for all purposes, were relatively so small that but little could be devoted to this work. Then another important factor requires consideration for a moment. Since the time of John Howard, reformer and public-spirited citizen, (and

even earlier) there have been many persons who, in a voluntary capacity, have been interested in the promotion of community welfare and more especially community health. Howard's investigations into the lazarettos during the latter part of the eighteenth century is an instance of his appreciation of the importance of health preservation and promotion and also an example of unselfish voluntary effort.

The care of the sick, of course, has always attracted and held the interest of many, but organized efforts to maintain health and to lessen the ravages of disease have only within the last half century gained great numbers of adherents. In certain fields these endeavors were initiated by official bodies such as the health departments, in other instances they were undertaken voluntarily by individuals or private agencies. Very often, of course, those interested in the voluntary effort were stimulated or encouraged or advised by those in official positions and best able to appreciate the importance and value of such voluntary assistance in extending the scope of organized public health efforts.

It has come about, then, that official departments of public health, federal, provincial or municipal, established by legal enactments, have usually been specifically called upon to develop public health educational work and in addition groups of individuals in many countries and many communities have banded themselves together for the purpose of (1) arousing public interest in the great and serious problems arising from the ravages of disease and ill-health, (2) enlisting public support in efforts undertaken for the amelioration of these conditions and (3) stimulating persons in every community to so order their municipal affairs that adequate financial provision will be made for those purposes which public health work includes in its broadest interpretation.

The purposes of public health education, whether undertaken by official or voluntary agencies, are precisely the same and may be summarized as follows:

1. To make known to every one in the community the simple, elementary facts of personal hygiene, which, if properly presented, will result in the creation of sound health habits among those so instructed; in other words arouse a widespread interest in positive health promotion.

2. To spread, in a similar fashion, a knowledge of those elementary facts of public health with which every one should be familiar; such as appreciation of the causes of preventable deaths and preventable sickness and disability; to the end that disease prevention through individual effort may widely and generally supplement and strengthen official action.

3. To make it abundantly clear that the prevention of disease, and not its treatment, should be the concern not only of physicians, nurses and public health workers, but of every man, woman and child in the community.

4. To indicate the relationships to public health of other related human efforts such as those undertaken to provide for recreation, physical education, and for the prevention and relief of poverty and destitution, and the amelioration of general conditions of life, in so far as such relationships are at present understood or determined.

Many methods have been proposed and actually utilized to accomplish these ends. These include:

(a) The publication and distribution of pamphlets, circulars, posters, leaflets and other varieties of educational material.

(b) The insertion in newspapers, magazines, and popular journals of articles dealing with health topics.

(c) Public health exhibits or demonstrations. These may be either temporary or permanent and are sometimes so organized that they may be conveyed from place to place. The organization of such traveling publicity campaigns and much useful information regarding them is given in Routzahn's Traveling Publicity Campaigns.

(d) Public health lectures with or without illustrative lantern slides, educational motion-pictures, etc.

(e) Educational motion-pictures alone, shown through the ordinary commercial channels (sometimes public health educational literature is distributed before or after the films are shown).

(f) Public health demonstrations in which the actual conduct of a given type of work is undertaken as for example, infant and child hygiene clinics, etc.

(g) By home visitation and demonstration. This is probably the most effective of all the various methods of conducting popular public health educational work. It is usually carried on by public health nurses or social workers. Tactful, sympathetic, well-trained and resourceful workers can do more in this way to inculcate a

knowledge of elementary personal hygiene and public health and to establish sound practices, than can be effected in any other way.

The use of public health nurses as educational agents in maternal and infant and child hygiene and in various other special fields of public health work have made it evident that a further extension in the direction of greatly increasing these health visitors will be entirely in the best interests of the community.

There are other methods of giving public health instruction such as that in educational institutions proper; the primary and secondary schools, normal colleges, and those universities where there are departments of university health service. The teaching in all of these should be closely related to that of physical education.

In order that the teaching of elementary hygiene and public health should reflect only accepted scientific truths, it is very important that all those who essay the task of public health education should be thoroughly trained. There is no other field, probably, in which so many persons inadequately prepared feel quite confident of their ability to offer advice and suggestions or indeed conduct educational work as in those relating to disease and health. Whether the aim be purely unselfish or whether there is some mercenary incentive as in the exploitation of patent or proprietary medicines or the propagation of some pseudoscientific belief or teaching, the end result can be satisfactory only if what is taught is based on sound scientific principles of physiology, biochemistry, bacteriology, immunology, epidemiology, etc.

Teachers of the principles upon which the maintenance of good health depends cannot acquire their knowledge in a few weeks. Formal and prolonged courses of instruction are as necessary for them as for other workers in any other scientific field. It is especially desirable that the physician in private practice as well as the public health physician, public health nurse and trained social worker do their share of this work because no one else should be so well qualified to do so. When the general public learns that physicians are actually more interested in keeping people well than treating them when they are sick and equally well qualified to do so, then the preventive side of the physician's work will expand greatly.

Nearly all departments of health, whether federal, state or provincial, or municipal of any size, now have divisions of publicity and

public health education, and in addition it sometimes happens that other administrative divisions in such departments also carry on active public health educational work. Then, too, other departments of federal and state or provincial governments charged with the administration of work related to public health, carry on propaganda work along similar lines.

In the United States and Canada the following Federal government departments circulate educational material of this character.

United States

1. **United States Public Health Service** issues circulars, pamphlets, and other types of literature dealing with all phases of pubic health work in addition to printing the weekly Public Health Reports and other similar publications. Requests for material should be addressed: Surgeon-General, United States Public Health Service, Washington, D. C.

2. **Children's Bureau,** United States Department of Labor, issues publications dealing with problems of maternal, infant, and child welfare. Communications should be addressed, Director, Children's Bureau, United States Department of Labor, Washington, D. C.

3. **Bureau of the Census** issues a Weekly Health Index; also other valuable statistical material. Information regarding this may be obtained by addressing Bureau of the Census, Department of Commerce, Washington, D. C.

A complete list of all publications of public health interest ("Health, including diseases, drugs and sanitation") may be obtained upon application to the Superintendent of Documents, Government Printing Office, Washington, D. C.

Canada

1. **Department of Health (Canada)** (Ottawa, Ontario) issues popular and scientific public health publications dealing with various aspects of the subject: Address Deputy Minister, Department of Health (Canada), Ottawa, Ontario.

2. **Dominion Bureau of Statistics** prepares and distributes public health statistical information. Address Superintendent, Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa, Ontario.

The different state and provincial departments of health also prepare and circulate a great variety of public health educational material. Some of these departments issue regular publications, as for example, the New York State Department of Health which publishes the Monthly Health News, and the Monthly Vital Statistics Review. Requests for literature dealing with any public health question addressed to the appropriate Department of Health in any of the various states or provinces in the United States or Canada receives immediate attention. All such publications are distributed gratuitously. In like fashion many municipal departments of public health publish bulletins, etc., at regular intervals and in addition frequently distribute pamphlets, circulars, etc., dealing with different important phases of preventive medicine and hygiene.

There are at present as has already been indicated a large number of associations organized locally or on broader state, provincial or national lines whose chief objects are the promotion of health. These are the so-called voluntary health promoting agencies. Many of them have been doing most valuable work in an auxiliary capacity for a great number of years and have rendered conspicuous service.

Among the first in the field in the United States and Canada was the National Tuberculosis Association, which had for its object the "study and prevention of tuberculosis." This organization with headquarters in the City of New York publishes a popular journal dealing with questions of health promotion, "The Journal of the Outdoor Life." In addition a special journal devoted to the scientific aspects of this most important subject, namely, the American Review of Tuberculosis. A great variety of valuable material bearing on the tuberculosis problem is also circulated, such as the Monthly Bulletin, Transactions, Tuberculosis Directory, etc.

In the United States other important nationally organized voluntary health promoting agencies are those dealing with the problems of maternal and infant mortality such as the American Child Hygiene Association with headquarters in Baltimore, which publishes a valuable monthly periodical, Mother and Child, also posters, circulars, etc. In the same field there is also the Child Health Organization of America in the City of New York.

In the campaign against venereal diseases valuable work has been

done by the American Social Hygiene Association (headquarters New York City) which publishes the Social Hygiene Quarterly and the Social Hygiene Bulletin, the latter being a monthly publication. In addition a great deal of excellent material such as educational motion pictures, lantern-slides (suitable for lectures or for use in so-called attractoscopes), posters, pamphlets, etc., may be obtained on application.

In the very big and important field of mental hygiene there is operating the National Committee for Mental Hygiene (headquarters New York City) which through surveys, the publication of the monthly journal, Mental Hygiene, and in a variety of other ways has done much to stimulate interest in the varied and serious problems of mental subnormality and abnormality. There is another voluntary organization, The American Society for the Control of Cancer with headquarters in New York City which has as its object a nation-wide effort "to disseminate knowledge concerning the symptoms, diagnosis, prevention and treatment of cancer, to investigate the conditions under which cancer is found and to compile statistics in regard thereto." In view of the present exceedingly high death rate from cancer, this is a most necessary effort. Educational material dealing with the subject of cancer may be obtained from the above organization which will be found suitable for public health propaganda work. For the correlation of efforts of these voluntary agencies in the United States there has recently been organized the National Health Council.

Two other extremely important organizations in the United States composed of special groups carry on most valuable public health work, the American Public Health Association (office in New York City) and the American Medical Association (headquarters Chicago). The American Public Health Association, in the field now for half a century, is composed of public health workers and others interested in the problems peculiar to this subject. The Association publishes the monthly American Journal of Public Health and other bulletins, etc., and holds an annual public health meeting, the largest and most representative public health gathering held on the North American Continent.

The American Medical Association, which is the organization of the medical profession in the United States, has initiated and conducted many most important and valuable public health and allied

campaigns. Reference has already been made to the campaign for a sane "Fourth," which resulted in a great reduction in tetanus deaths. In addition under the auspices of the Council on Health and Public Instruction a most important survey of State Public Health work was conducted. In addition public health educational literature of all kinds is published and distributed.

Perhaps the most unique and valuable work of the American Medical Association from an international public health standpoint has been the great campaign carried on under the title of the "propaganda for reform," through which the enormous extent and great harm wrought by the indiscriminate sale and consumption of huge quantities of proprietary and patent medicines has been thoroughly exposed. Fake "consumption" and "cancer cures" have been exposed, and the useless and almost criminal waste of millions of dollars annually, to say nothing of thousands of lives, through the use of these nostrums (resulting very often in fatal delay on the part of the patient in consulting a physician in early cases of malignant disease, tuberculosis, etc.) has been pointed out.

There is almost no other question of greater moment at the present time than the exploitation on an unparalleled scale of the general public by nostrum and patent medicine vendors. Self-medication and indiscriminate use of "cures" and remedies of all sorts and descriptions is so universally indulged in that it has almost ceased to excite any comment. If, however, the huge sums of money now literally wasted in this manner were expended on public health promotion through organized community effort and on periodic medical examinations, etc., the saving in lives and money would be incalculable. This can be brought about only through publicity and educacation. Extensive demonstration work in the field has been carried on in many states by the International Health Board of the Rockefeller Foundation, with very great success.

In Canada very excellent, nationally organized, voluntary health promoting agencies exist as follows:

1. **The Canadian Association for the Prevention of Tuberculosis** (headquarters, Ottawa, Ontario) distributes most useful posters, pamphlets, reports, etc., and general propaganda work in this field is undertaken. This is the pioneer voluntary health organization in Canada.

2. **The Canadian National Committee for Mental Hygiene** (Toronto, Ontario) conducts surveys, publishes a monthly journal and bulletin, issues special reports, and does other valuable work in mental hygiene in cooperation with governmental and voluntary agencies.

3. **The Canadian National Council for Combating Venereal Diseases** (office, Toronto). This organization, like the American Social Hygiene Association and the National Council for Combating Venereal Disease and the Society for the Prevention of Venereal Diseases in Great Britain, carries on active propaganda work as the voluntary agency recognized and supported by the Department of Health, Canada, for combating venereal diseases. By means of educational motion pictures, pamphlets, posters, and through lectures, etc., a great deal of important work is carried on.

4. **The Child Hygiene Section of the Canadian Public Health Association** (headquarters, Toronto) is a national voluntary organization doing auxiliary work for the Provincial and local departments of health in infant and child hygiene. By preparation and showing of motion pictures, distribution of educational literature folders, diet sheets, posters, etc., large numbers of persons are interested in the most necessary work of reducing infant mortality. There is also the Canadian Public Health Association, of which the last mentioned agency is a section, which is made up of public health workers and others interested, which holds an annual meeting, publishes the monthly Public Health Journal and spreads health propaganda throughout Canada.

In addition to the national organizations enumerated, there is another group of agencies constituting the League of Red Cross Societies with headquarters in Geneva, and including the National Red Cross Societies in a great many countries. The League and its independent, but affiliated National Red Cross Societies have as one of their aims "the promotion of health, the prevention of disease, and the mitigation of suffering." The National Red Cross Societies are voluntary, auxiliary bodies to the duly constituted health departments in the countries, states or provinces or municipalities in which they are established. The League publishes the International Journal of Public Health, and like the constituent societies publishes and distributes much public health educational material. In addition these societies promote and support public health nursing

education, contribute to the support of public health nursing services, conduct public health information bureaus, assist in supporting other voluntary health promoting agencies and endeavor to extend through a broad membership, a knowledge of the principles of healthy living.

In the field of international public health effort there is one other organization, the "Office International D'Hygiène Publique," in Paris from which there is issued the "Bulletin Mensuel," in which data in regard to vital statistics, morbidity, etc., in various countries throughout the world, is published.

The agencies and organizations already indicated are not all those at present operating nationally or internationally, there are others doing valuable work and, of course, many important organizations interested in the promotion of public health as one of several objects. It is impossible to mention all of these individually or do more than refer to the local voluntary health agencies although their work is in many cases of the utmost value. Physicians everywhere should be active in the work of these organizations in order that only those objects will be promoted which are really in the best interests of public health in any community.

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APPENDICES

INDUSTRIAL HYGIENE

BY J. G. CUNNINGHAM, M.B.,
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APPENDIX A

NEW JERSEY LIGHTING CODE

CODE OF LIGHTING *for Factories, Mills and Other Places, 1916:*

Rule 1.—General Requirements:

Working or traversed spaces in buildings or grounds shall be supplied during the time of use with artificial light, in accordance with the following rules, when natural light is less than the intensities specified in Rule 2.

Rule 2.—Intensity Required:

The desirable illumination to be provided and the minimum to be maintained are given in the following table:

	Foot-Candles at the Work. Ordinary Practice.	Minimum.
(*a*) Roadways and yard thoroughfares	0.05— 0.25	0.02
(*b*) Storage spaces	0.50— 1.00	0.25
(*c*) Stairways, passageways, aisles	0.75— 2.00	0.25
(*d*) Rough manufacturing, such as rough machining, rough assembling, rough bench work........	2.00— 4.00	1.25
(*e*) Rough manufacturing involving closer discrimination of detail	3.00— 6.00	2.00
(*f*) Fine manufacturing, such as fine lathe work, pattern and tool making, light-colored textiles	4.00— 8.00	3.00
(*g*) Special cases of fine work, such as watch making, engraving, drafting, dark-colored textiles	10.00—15.00	5.00
(*h*) Office work, such as accounting, typewriting, etc.	4.00— 8.00	3.00

NOTE.—Measurements of illumination to be made at the work with a properly standardized portable photometer.

Rule 3.—Shading of Lamps:

Lamps shall be suitably shaded to minimize glare.

NOTE.—Glare, either from lamps or from unduly bright surfaces, produces eye-strain and increases accident hazard.

Rule 4.—Distribution of Light on Work:

Lamps shall be so installed in regard to height, spacing, reflectors or other accessories, as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensity.

Rule 5.—Emergency Lighting:

(*a*) Emergency lights shall be provided in all work space, aisles, stairways, and passageways; at all exits and on all outside landings of fire escapes or other structures used as regular or emergency means of egress.

NOTE.—Outside lighting may be automatically controlled by interconnecting with an approved interior fire alarm system so arranged as to be automatically lighted and to remain lighted concurrently with the sounding of the alarm. Outside lighting units thus arranged need not be illuminated throughout the period in which artificial light is used as required by Rule 5-B, except upon written order of the Commissioner of labor.

(*b*) Emergency lighting systems, including all supply and branch lines, shall be entirely independent of the regular lighting system and remain lighted throughout the period of the day during which artificial light is required or used.

(*c*) Emergency lighting systems shall be supplied from a source independent of the regular lighting system wherever possible. This source of supply and controlling equipment shall be such as to insure the reliable operation of the emergency lighting system when through accident or other cause the regular lighting system is extinguished. Where a separate source of supply cannot be obtained for the emergency lighting the feed for emergency lights must be taken from a point on the street side of all service equipment. Where source of supply for the regular lighting system is an isolated plant within the premises an auxiliary service of sufficient capacity to supply all emergency lights must be installed from some outside source, or suitable storage battery; or separate generating unit may be considered the equivalent of such service.

Rule 6.—Switching and Controlling Apparatus:

(*a*) Switches or other controlling apparatus shall be so installed that pilot or night lights may be controlled from a point at the main entrance of factory building. Pilot or night lights may be a part of the emergency lighting system.

(*b*) All switching and control apparatus on emergency, pilot, or night lines shall be plainly labeled for identification.

Rule 7.—Plans, Specifications, Inspection, and Fees:

Plans to be submitted for approval of Bureau of Electrical Equipment and finished work subject to inspection, the fee for such examination and inspection being payable in advance.

For general information and suggestions see Code of Lighting, published by State Department of Labor.

APPENDIX B

WISCONSIN REGULATIONS ON EXHAUST SYSTEMS

AIR SPACE REGULATIONS—*Industrial Commission Order, 2016, 1919:*

In all rooms or places of employment where less than 900 cu. ft. air space per employee—in which there is no smoke, gas, fumes, dust, vapors, or fires which consume oxygen—to be provided with ventilating system which will change air at least twice each hour, and so designed as not to cause injurious drafts or reduce temperature materially below the average maintained.

EXHAUST SYSTEM—*Industrial Commission Orders, 2000-2015, 1919:*

Grinding, buffing, and polishing wheels, except wheels where water applied at point of grinding, to be equipped with a hood, hood to cover wheel in such a manner as to carry off dust in so far as work permits. On wheels 4 inches or less in width, with hood to be 6 inches; on wheels over 4 inches in width, hood not to be less than 2 inches nor more than 3 inches wider than width of wheel—wheels to be measured across face.

Size of suction pipe on hoods for grinding, buffing, or polishing wheels to be as follows:

Diameter of Wheel.		Diameter of suction pipe.	
6 inches to	10 inches	3 inches to	4 inches
10 "	18 "	4 "	5 "
18 "	24 "	5 "	6 "
Over "	24 "	6 "	

Where two sizes pipe specified above, smaller size not to be permitted except where hood covers two-thirds of wheel, or where work to be done is so light that dust is easily exhausted.

On all grinding, buffing, and polishing wheels suction in connection with hood to be sufficient to displace a column of water in a U tube, 5 inches. Test for suction with the U tube to be a static test and made in following manner: Hole 1/8-inch in diameter to be made in suction pipe approximately 12 inches from connection to the hood; rubber hose attached to U tube to be placed over the 1/8-inch hole and test made under these conditions; when water in tube stands at 0, 5-inch displacement secured when one column of water rises 2 1/2-inches above O and other column of water falls 2 1/2-inches below O.

Branch suction pipes to enter main pipe in direction of the flow of air and at an angle not exceeding 45 degrees, measured from a line drawn parallel with current of air in main suction pipe. Main suction or trunk pipe on all wheels to be placed below and as close to wheels as possible. Bends, turns, and elbows in suction and discharge pipes to be made with smooth interior surfaces

and radius of curvature of elbows, measured from the centre of pipe, not to be less than twice the diameter of such elbows.

Dust discharged from any exhaust system to be taken care of by dust collector, air washer, or other adequate system which will prevent it from contaminating the air in or around place of employment.

All belts, drums, rolls, or disks used for grinding, buffing, polishing, or sanding, to be equipped with exhaust system so designed and attached that it will carry off dust in so far as work will permit.

Sand blasting operations, not performed under an enclosed hood, to be performed in room set aside for that purpose; such room to be equipped with exhaust system which will change air in the room not less than 4 times per minute; employees working in such rooms to be furnished with suitable covering for the face, which will protect eyes, nose, and mouth.

All tumbling barrels and rattlers to be equipped with an exhaust system which will remove all particles of dust which are light enough to float in the air. All machines which create and throw off dust sufficiently light to float in the air to be equipped with an exhaust system so designated and attached as to carry off dust in so far as work will permit.

All vats and tanks containing liquids which emit fumes or vapors of ammonia, arseniuretted hydrogen, carbon dioxide, carbon monoxide, carbon tetrachloride, chlorine, gases from pickling vats, lead and mercury, phosgene, sulphur dioxide, hydrochloric acid, nitric acid, sulphuric acid, prussic acid, or other fumes or vapors which are irritating, obnoxious, or injurious to health, to be equipped with ventilating system which will remove as much of fumes or vapors as work will permit.

All furnaces and forges which emit gas or smoke in such quantity as to be irritating, obnoxious, or injurious to health, to be equipped with ventilating system which will remove as much of the gas and smoke as work will permit. Where heat or humidity caused by work is such as to be injurious to health, means of ventilation to be provided which will reduce heat and humidity to as reasonable a degree as nature of work permits. Where air is so dry as to be injurious to health, to be properly humidified.

All foundries, forge shops, roundhouses, and other places of employment in which smoke, gas, dust, or vapors present in sufficient quantities to obstruct the vision, or to be irritating, obnoxious, or injurious to health, to be equipped with system of ventilation which will eliminate such smoke, gas, dust, or vapors in so far as conditions of industry will permit; such system of ventilation to change the air in room not less than twice each hour, and to supply room with additional amount of air to make up for loss of oxygen which is consumed by the fires; each person in room to be supplied with not less than 1,800 cu. ft. fresh air each hour.

APPENDIX C

BRITISH LEGISLATION RELATING TO EMPLOYMENT OF CHILDREN

The following is an extract from the Factory Acts of Great Britain relating to employment of children.

SECTION 62.—A child under the age of twelve years must not be employed in a factory or workshop unless lawfully so employed at the commencement of this Act.

SECTION 63.—(1) In a factory a young person under the age of sixteen years or a child must not be employed for more than seven or, if the certifying surgeon for the district resides more than 3 miles from the factory, thirteen work days, unless the occupier of the factory has obtained a certificate, in the prescribed form, of the fitness of the young person or child for employment in that factory.

(2) When a child becomes a young person, a fresh certificate of fitness must be obtained.

(3) The occupier shall, when required, produce to an inspector at the factory in which a young person or child is employed the certificates of fitness of that young person or child for employment.

SECTION 64.—With respect to a certificate of fitness for employment for the purpose of this Act, the following provisions shall have effect.

(1) The certificate shall be granted by the certifying surgeon of that district.

(2) The certificate must not be granted except upon personal examination of the person named therein.

(3) A certifying surgeon shall not examine a young person or child for the purpose of the certificate or sign the certificate elsewhere than at the factory where the young person or child is, or is about to be, employed, unless the number of young persons and children employed in that factory is less than 5 or unless for some special reason allowed in writing by an inspector.

(4) The certificate must be to the effect that the certifying surgeon is satisfied, by the production of a certificate of birth or other sufficient evidence, that the person named in the certificate is of the age therein specified, and has been personally examined by him and is not incapacitated by disease or bodily infirmity for working daily for the time allowed by law in the factory named in the certificate.

(5) The certificate may be qualified by conditions as to the work on which a child or young person is fit to be employed, and if it is so qualified, the occupier shall not employ the young person or child otherwise than in accordance with the conditions.

(6) A certifying surgeon shall have the same powers as an inspector for the purpose of examining any process in which a child or young person presented to him for the grant of a certificate is proposed to be employed.

(7) All factories in the occupation of the same occupier and in the district of the same certifying surgeon, or any of them, may be named in the certificate, if the surgeon is of the opinion that he can truly give the certificate for employment therein.

(8) The certificate of birth (which may be produced to a certifying surgeon) shall either be a certified copy of the entry in the register of births, kept in pursuance of the Acts relating to the registration of births, of the birth of the young person or child (whether that copy is obtained in pursuance of the Elementary Education Act, 1876, or otherwise), or be a certificate from a local authority within the meaning of the Elementary Education Act, 1876, to the effect that it appears from the returns transmitted to that authority in pursuance of the said Act by the registrar of births and deaths that the child was born at the date named in the certificate.

(9) Where the certificate is to the effect that the certifying surgeon has been satisfied of the age of a young person or child by evidence other than the production of a certificate of birth, an inspector may, by notice in writing annul the surgeon's certificate if he has reasonable cause to believe that the real age of the young person or child named in it is less than that mentioned in the certificate, and thereupon that certificate shall be of no avail for the purpose of the Act.

(10) Where the certifying surgeon refuses to grant a certificate for any person examined by him, he shall, when required, give in writing and sign the reasons for his refusal.

APPENDIX D

SCOPE OF PHYSICAL EXAMINATION

With Forms for Recording Findings

1. Superficial Inspection.—This consists of a hasty survey for obvious defects and apparent sickness. It considers height, weight, appearance, deformities, distance vision, hearing, hernia, and occasionally the heart and lungs (stethoscope applied outside of shirt). Its objective is rejection of the evidently unfit and exclusion of communicable diseases.

2. Inspection.—This consists of a more complete survey. All parts of the body are exposed and their condition noted. Diagnostic instruments are used when in the opinion of the physician they are needed. This is practically an examination—without urinalysis and other laboratory tests. Its objective is selection and assignment of workers.

3. Examination.—This consists of a reasonably complete survey of the body according to accepted methods, and includes blood-pressure readings and urinalysis. It is virtually the same as the examination required by life insurance companies. Its objective is not only the selection and assignment of workers, but their health supervision as well.

4. Special Examination.—This consists of all measures that are necessary to a thorough study of the body, including intraocular observations, gastric analysis, rectoscopy, cystoscopy, X-ray interpretations, investigations of the nervous system, blood counts, etc. Very few industrial physicians are prepared to make such elaborate and painstaking examinations. Individuals needing them are usually referred to consultants. The objective of the special examination is the diagnosis of obscure diseases and pathological conditions. It belongs rather to the realm of internal medicine than to industrial.

ROUTINE FOR PHYSICAL EXAMINATION

Used by the National Malleable Castings Company

The worker is received fully clothed and remains standing until the feet are inspected. He is greeted in a friendly manner, and attempts are made to put him at ease if embarrassed or backward.

1. As he enters gait, carriage and appearance are observed.
2. He is weighed and measured for height.
3. Vision, both near and far, is tested.
4. The right ear and right side of head and neck are inspected. While this is being done the hearing on that side is estimated by a question in a low voice.
5. This procedure is repeated on the left side.

Suggested Forms for Recording Results of Physical Examination

FIGURE I

REPORT OF PHYSICAL EXAMINATION

Date.................

Check No................. Name .... Age ....

FINDINGS.

Date of Examinations																	
Classification	R	L	R	L	R	L	R	L		R	L	R	L	R	L	R	L
Eyes									Inguinal Region								
11 Defective Vision									55 Inguinal Hernia								
12 Old Injury									56 Inguinal Adenitis								
13 Conjunctivitis									57								
14 Trachoma									Genito-Urinary								
15 Interstitial Keratitis									58 Chancre								
16									59 Varicocele								
Ears									60 Hydrocele								
17 Wax in Ears									61 Undescended Testicle								
18 Otitis Media									62 Epididymitis								
19 Deafness from Other Causes									63 Gonorrhea								
20									64								
Nose									Extremities								
21 Old Fracture									65 Old Fracture								
22 Obstruction									66 Old Mutilation								
23									67 Varicose Veins								
Throat and Mouth									68 Ankylosed Digits								
24 Pharyngitis									69 Other Ankylosed Joints								
25 Enlarged Tonsils									70 Wrist Deformities								
26 New Growth									71 Flat Foot								
27 Syphilis									72 Bunion								
28									73 Ingrowing Toe Nails								
Teeth									74								
29 Defective Teeth									Arteries								
30 Malocclusion									75 Arteriosclerosis								

31					76 Aneurism				
Tongue					77				
32 New Growth					Blood Pressure				
33 Syphilis					78 Systolic				
34					79 Diastolic				
Neck					80				
35 Goiter					Skin				
36 New Growth					81 Acne				
37					82 Eczema				
Lungs					83 Psoriasis				
38 Pulmonary T. B.					84 New Growth				
39 Pleurisy					85 Syphilis				
40 Acute Bronchitis					86 Other Infectious Diseases				
41 Asthma					87 Scars or Identification Marks				
42 Emphysema					88				
43					General				
Heart					89 Weight in Pounds				
44 Valvular Disease					90 Height				
45 Myocarditis					91 General Appearance				
46					92				
Abdomen					Urinalysis				
47 Enlarged Liver					93 Sugar				
48 Enlarged Spleen					94 Albumin				
49 Chronic Appendicitis					95 Sp. G.				
50 Ventral Hernia					Miscellaneous				
51 New Growths					96				
52 Kidney Lesions					97				
53					98				
54					99				

NOTE:—Mark √ to indicate defects that do not require medical measures. × that require medical measures but do not disqualify. * that disqualify. Describe × and * on other side, using reference numbers and diagrams where necessary.

FIGURE II

PHYSICAL EXAMINATION OF APPLICANTS FOR INDUSTRIAL WORK

A Small but Comprehensive Record Recommended by C. D. Selby, Consulting Hygienist, United States Public Health Service

(Front)

Name			Clock No.	Dept. No.
Address			Married Single	Age
Nationality	Occupation	Date Employed	Date Examined	Referred by

What diseases have you had?			
Nature	Date	Duration	Complications
What injuries, accidents, or surgical operations have you had?			
Nature	Date	Duration	Results
Have you ever had?			
Hernia	Rheumatism	Fistula	Venereal Disease

Signed........................

Height	Weight	Temperature	Inspection and palpation of head and neck

Tongue	Teeth	Gums	Throat	Nasal passages

(Back)

Right Vision:	Left	Colorblind	Wear glasses	Right Hearing	Left

Auscultation	Percussion

Lungs: Sounds Heart:	Rhythm	Size	Blood Pressure	Systolic	Diastolic	Pulse Pressure

Character of Pulse:	Condition of arteries	Inguinal or femoral hernia
Condition of abdominal viscera:		

Urinalysis:	Spec. Gravity	Albumin	Sugar	Sediment	Microscopic
Pupils	Tremors	Stellwag Groef's Romberg	Spine	Glands	Reflexes

Scars or deformities from operation, injury, or disease

Evidence of infectious disease ....

Accepted	Physically unfit	Rejected

Why, ...

(Signed) ....

Examining Physician.

FIGURE III

FORM FOR PHYSICAL EXAMINATION OF APPLICANTS FOR INDUSTRIAL WORK

(Copy of form used by the Medical Dept. of the Pullman Company and devised by Dr. T. R. Crowder.

Serial No.	File No.

Name

For position of

In the Dept.

Of the Shops 19

Date	Occupation	Check No.

Age Sex Nationality Civil State Address

Last Employed By As

How Long in This Occupation Time Lost From Sickness During Last Year

How Much Use of: Tobacco Liquor Beer

What Previous Diseases or Injuries

Report of Defects:

Height	Vision: Without Glasses: R. L. With Glasses: R. L.
Weight	Hearing
Development	Eyes
Nourishment	Teeth
Expansion	Gums
Respirations	Throat
Pulse	Respiratory System
Temperature	
Blood Pressure	
Hernia	
Constipation	Vascular System

Nervous System

Digestive System and Abdomen

Genito-Urinary

Urine: Sp. Gr. React. Alb. Sug. Mic. Sed.

Blood: Hgb. Whites Reds Path.

Skin

Bones, Extremities

Applicant is a Subject for the Occupation Named and is Approved for Employment.

Obverse side. ...., M.D.

MONTHLY EXAMINATIONS

Year	Day	Weight	Blood Press.	General Appearance	Condition of Teeth, Gums, etc.	Doctor's Initials	Year	Day	Weight	Blood Press.	General Appearance	Condition of Teeth, Gums, etc.	Doctor's Initials
Jan.							Jan.						
Feb.							Feb.						
Mch.							Mch.						
Apr.							Apr.						
May							May						
June							June						
July							July						
Aug.							Aug.						
Sept.							Sept.						
Oct.							Oct.						
Nov.							Nov.						
Dec.							Dec.						
Jan.							Jan.						
Feb.							Feb.						
Mch.							Mch.						
Apr.							Apr.						
May							May						
June							June						
July							July						
Aug.							Aug.						
Sept.							Sept.						
Oct.							Oct.						
Nov.							Nov.						
Dec.							Dec.						

Reverse side of Fig. III.

Jan.							Jan.						
Feb.							Feb.						
Mch.							Mch.						
Apr.							Apr.						
May							May						
June							June						
July							July						
Aug.							Aug.						
Sept.							Sept.						
Oct.							Oct.						
Nov.							Nov.						
Dec.							Dec.						

NOTES: This side is used for notes on monthly inspections of workers in occupations where they are exposed to occupational disease

Reverse side continued

FIGURE IV

NATIONAL LAMP WORKS OF GENERAL ELECTRIC COMPANY

PHYSICAL EXAMINATION

Name............................ Date............

Height...........

Dept. .... Sex.............. Weight...........

Nutrition ....Deformities ....Tonsils ....

Bad Cough ....Anaemia...... Hb........Teeth ....

(See Dental Chart)

Heart ....Glands ....Goiter ....

Blood-Pressure Sys. Diast.....Vision: Distant R....L....Hernia: R...............

Lungs .... Reading R....L.... L...............

Hearing: Watch R...L...Astigmatism R......L.....Urine ....

Whisper R...L..History Eye Strain.......Micro. Urine.............

Nervousness ....Glasses Yes No ....

Operations (Age) ....

....

....

Obverse Side

History of Previous Illness, etc. ....

....

....

History of Exposure to Tuberculosis in family ....

....

Vaccination: Smallpox ....

Detailed Examination of Such Abnormalities As May Seem Necessary, i. e., Heart Murmurs, Chest Findings, etc.

....

....

....

....

....

....

....

....

....

....

....

....

....

Reverse Side

6. The face is inspected; the condition of the eyes is noted by lifting and depressing the lids; the nares, the mouth and teeth, then also the throat and the anterior surface of the neck are observed.

The worker is requested to remove all clothes from the waist up.

7. The chest is inspected and the condition of the heart and lungs estimated by percussion and auscultation.

8. The abdomen is inspected and the condition of the organs estimated by palpation and percussion.

9. The back is inspected and the posterior aspects of the lungs estimated by percussion and auscultation.

10. The spine is palpated and flexed.

The worker is requested to loosen his trousers and undergarments and let them fall down around the ankles.

11. The external genital organs and inguinal regions are inspected and palpated.

12. The sacro-iliac articulations are examined and the anal region inspected.

13. All extremities are inspected, mobility of joints and condition of blood vessels being especially observed.

The worker is now requested to draw up his underclothing and trousers, after which he is directed to sit down and take off his shoes and socks.

14. The ankles and feet are inspected. If there is any doubt about the arches, impressions are taken.

15. Blood-pressure readings are taken (optional).

16. A specimen of urine is obtained (optional).

The worker is now dismissed. During the inspection as defects appear, the physician is expected to inform the worker of their presence and to give him such advice as may seem wise, an interpreter being used when needed. Special features are emphasized immediately before departure and further advice given if necessary to enable the worker to do his work without hazard to health. ("Scope of The Physical Examination in Industry," C. D. Selby, Journal of Industrial Hygiene, Dec., 1919, p. 381.)

APPENDIX E

REPORT FORMS FOR VISITS OF AN INDUSTRIAL NURSE

Forms Quoted by C. D. Selby, Consulting Hygienist, United States Public Health Service, and others.

FIGURE I.

INFORMATIVE REPORT ON NURSE'S VISIT TO SICK ABSENTEE

Acute
Chronic

Name.............................. Date ....
Dept.............................. Address ....
Ailment ....
....
Probable period of disability.......................Physician ....
Member of Relief Association........................Married ....
Single ....
Home Conditions ....
.... Children ....
Patient's Statement ....
....
Nurse's Statement...
....
Nature of treatment...
Signed ....

FIGURE II

REPORT OF NURSING VISIT ON CASE OF PATIENT.

Name..............................Address......................File No.

	First case	Second case	Third case
Diagnosis	....	....	....
Complications	....	....	....
Date of first visit	....	....	....
Date of last visit......	....	....	....
Total visits...........	....	....	....
Condition on discharge.	....	....	....
Dismissed to	....	....	....
Physician.............	....	....	....

Visits Made

Date	Patient's condition	Physician's orders	Services rendered
....	....	....	....
....	....	....	....

FIGURE III

REPORT OF VISITING NURSE TO FOREMAN.

To the foreman of..Department

..................................191...

Mr.............................reported absent ....

because of sickness, received a call from the nurse today.

Ailment ....

Physician ....

Probable period of disability..

Nurse's statement ....

....

....

Visiting Nurse.

FIGURE IV

WEEKLY REPORT OF VISITING NURSE.

....................District For week ending..........191...

Nature of visit	S	M	T	W	T	F	S	Total	Locations Visited	New calls Nationality
Nursing visits..........										American...
										English....
Casual............										German....
										Finnish.....
Child Welfare........										French.....
										Polish......
Prenatal..........										Slovaks....
										Irish.......
Nursing Instruction										Italian.....
										Norwegian.
Interviews........										Swedish....
										Bulgarian..
Investigations.....										Austrian...
Total.........										

Plans and suggestions..

....

Visiting Nurse.

FIGURE V

MONTHLY REPORT OF VISITING NURSE

................District For month of.......... 191...

Patients continued from last month..
New Patients..
Total patients cared for during month......................................
Number needing no further care...
Number transferred to hospital or other care...........................
Number died ....
Patients still being cared for..

Summary of Visits

Nursing visits ....
Casual ....
Child welfare ....
Prenatal ....
Nursing instruction ....
Interviews ....
Club meetings ....
New families visited ....

Classification of New Patients for Month

Number of adults................Male ....Female ....
Number of children under 15......Male ....Female ....

Nationality of New Patients for Month

American	Polish	Swedish ....
English	Slovak	Bulgarian ....
German	Irish	Austrian ....
Finnish	Italian	
French	Norwegian	

Diseases of New Patients for Month

Appendicitis	Infants, care of	Pul. tuberculosis ....
Bowel trouble	Infections	Quinsy ....
Bronchitis	Injury	Rheumatism ....
Burns	Kidney trouble	Rupture ....
Catarrhal fever	Locomotor ataxia........	Senility ....
Cold	Malnutrition	Sore eyes ....
Colic	Mastoiditis	Sprains ....
Eczema	Nephritis	Stomach trouble ....
Enteritis	Neuralgia	Tonsillitis ....
Epileptic	Obstetrical	Typhoid fever ....
Gastritis	Pleurisy	Unclassified ....
General debility	Pneumonia	Undiagnosed ....
Heart trouble	Post operative	Var. ulcer ....

....
Visiting Nurse.

FIGURE VI

FORMS RECOMMENDED BY FLORENCE S. WRIGHT, BUREAU OF CHILD HYGIENE, NEW JERSEY STATE DEPARTMENT OF HEALTH.

(Front)

Dept. ....PERSONAL HISTORY CARD No. ....
Name ....Citizen? ......1st papers..... 2nd papers.....
Address .... Telephone No. ....
Place and date of birth ....
Relatives living? Father.................. Nationality ....
Mother..........................Nationality ....
Brothers........................Sisters.....Children (Sex and ages).....
Wife ....Employed ....Where
Hus. ....Employed ....Where .... Citizen?..........
Wage Earners ....

School Training: yrs. in U. S........yrs. abroad.......Grade in U. S........
Date of immigration.........English, Speaks......Reads......Writes......
Religion? ....
Societies? ....
Last employer? ....Why left? ....
Previous employer? ....Why left? ....
Assigned to.................Dept.................. No. ....
Operation...................Wage................. Date ....

HOME: Live at?........No. Rooms......No. occupants......Boarders......
Sanitary Condition ....
Home visits by nurse (1st & last at each absence) ....
....
....
Remarks ....
....
In case of accident notify ....
Possible transfer to....Purch., op., Stock, Design, Exam., Sales, Cut., Trim., Press., Ship., Mach., Clerical.......................................

FIGURE VII

(Back)

First Aid Room Name Dept.

Date	Hour	Disability	How injured	Disposition or treatment remarks
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

Home visiting

Date	Disability	Dates of visit, services rendered, remarks
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

FIGURE VIII

Nurse's Report—Employees' Service Department, Cincinnati Milling Machine Co.

Name (last name first)	Ck. No.	Dept.	Class of Work	Date Employed	Date Joined E. H. I. A.	Native Country or State	Alien Naturalized U. S. Citizen Cit. of Cincinnati	Male Female White Colored

Addresses and Dates of Changes

Married / Single / Widowed / Divorced

Name of Wife—Mother

Names and ages of Children

(Date)

Church Affil.

Name, relationship and occupation of head of family (where employed)

Past Absence Record

Chief cause of Absence

Rel. in Shop?

Past Medical Record

Date of Visit	Absent Since	Date He Expects to Return	CAUSE OF ABSENCE AND SERVICE RENDERED Record nature of illness, temperature, name of attending physician, and his diagnosis. If injured, where did accident occur, nature and extent of injury? If a State Industrial case, have papers been signed? Did patient send for nurse?	Did he notify shop of absence	Did he report to Dispensary before	General Shop Efficiency	Av. Total Weekly Wage	Keeping House, Rooming or Boarding	Number of Rooms	Monthly Rent	SANITARY CONDITIONS			Employee's Attitude	Family's Attitude
											Neighborhord	House	Rooms		

APPENDIX F

EMPLOYEE'S INDIVIDUAL RECORD CARD

RECORD OF ABSENCES FROM DISABLING SICKNESS AND FROM ACCIDENT

Back

15. Dates of absence		16. Number of days lost through* *If physician or nurse saw patient mark "x" beside number			17. Diagnosis: where made by physician mark (p) after the diagnosis as "Sciatica" (p)	18. Abnormal circumstances causing temporary increase in lost time from disability, e.g. epidemic, explosion	19. Gen. Remarks (e.g. Living conditions)
Beginning	End	Sickness	Non-Industrial accident	Industrial accident			

Front Note accompanying explanations for terms used on this card (on next page).

1. Name of Employee	2. Check No.	3. Date this record begins	4. Firm No.	5. Date Employment ended

6. Sex	7. Year of Birth	8. Marital condition	9. Birth place of Father	10. Speaks English?	11. Reason Employment ended

12. Departments and Occupations in Plant.

From—	To—	Months	Department	Occupation	Possible Injurious Conditions

13. Former Occupations Outside of Plant.

From—	To—	Months	Occupation	Industry	Possible Injurious Conditions

14. Remarks

EXPLANATION OF TERMS

In order that the information recorded on the accompanying cards may be as accurate as possible, it is highly desirable that the following interpretation be placed on the terms used.

The face of the card should be filled out for each Employee at the time of his employment. The reverse side should be filled out as cases of disabling illness occur. The card is then kept in an active file, subdivided by departments, so long as the employee remains with the establishment, and after that in an inactive file. When the employee is moved from one department to another the card should be revised to cover this change, in the space given to occupation, the date of the change recorded, and the card transferred to the subdivision of the department to which the employee goes.

2. **Check Number:**

The employee's number should be used in case numbers instead of names appear on the pay-roll of the company.

4. **Firm Number:**

Each company co-operating with the Committee on Industrial Fatigue of the Honorary Advisory Council for Scientific and Industrial Research of the Dominion Government will be given a number so that the identity of a particular firm may at all times be kept strictly confidential.

5. **Date Employment Ended:**

Give date of termination of service if employee resigned, or was discharged, or of death, if employee died.

8. **Marital Condition:**

State whether married, single, widowed or divorced.

12 and 13. **Occupation:**

Occupation should be stated definitely to indicate the particular kind of work done in the department. For example:—sand blaster of metal parts, japanner, oven tender, mixer, wringer, dipper. Do not use such indefinite terms as laborer, machinist, foreman, operator.

Possible Injurious Conditions:

Record any working conditions in specific occupations which might be considered harmful, as exposure to excessive heat, cold, humidity, poisonous dusts, fumes, vapors, gases, or liquids; the handling of materials known to retain harmful bacteria, heavy lifting, muscular strain or long hours of labor. Possible health hazards of all kinds should be determined by the plant physician where one is employed.

[OVER

13. **Former Occupations Outside of Plant:**

If the employee has engaged in numerous occupations prior to employment by the present company, only two occupations which immediately preceded work in the present plant should be recorded.

15. **Dates of Absence:**

The date of beginning of absence is the date on which the employee quit work, irrespective of the hour. The date absence ended is the date prior to the one on which the employee returned to work, irrespective of the hour. If the employee is absent for only a fraction of a day, do not record the illness or accident, as only disability incapacitating for one day or longer should be included.

16. **Days Lost Through:**

(a) Sickness

(b) Non-industrial accident—that is accident occurring outside work hours and while the employee was neither in the plant nor engaged in work for the company.

(c) Industrial accident—that is accident occurring while the employee was on duty.

In each case (a), (b) and (c) "time lost" is the period between the date of the beginning and the date of the close of absence, *excluding Sundays and holidays.*

Where a physician or nurse saw the patient, whether a case of sickness, non-industrial accident or industrial accident, mark "x" beside the number—for example 9 x.

18. **Indicate Abnormal Circumstances Causing Temporary Increase in Lost Time from Disability:**

Note such conditions as prevalence of influenza or other epidemics or local infections, explosions, fires or other circumstances causing disability among the plant employees.

19. **General Remarks:**

Give any additional information pertinent to the industrial case—for example:

(a) Chronic disability of any kind.

(b) Features of home life likely to affect employee's own health and efficiency, *e.g.*, bad housing conditions, sickness in family.

APPENDIX G

FORM FOR TABULATION OF TIME LOST FROM SICKNESS AND COMPLETED SAMPLE

(Devised by Division of Industrial Hygiene of the Provincial Board of Health of Ontario)

TABULATION OF TIME LOST

1			2				3					
No. of employees			No of sick employees				Number of days lost through cases of sickness in each					
Men	Women	Both	Men	Women	Both	Department						

Directions.—The number of cases of sickness involved in each instance is to be recorded in the triangle within the squares—see sample tabulation form.

THROUGH SICKNESS

Firm No.____ Year 4 ____ Month 5 ____

Sickness and number of occupation by disease								Total Absence			Remarks
							Total no. of days lost in each occupation by all diseases	Total No. of days lost in each occupation through sickness and all other causes			E. G. High proportion of:- (a) Workers of sub-normal physical or mental capacity (b) Married Women (c) Extremes of age (d) Foreigners
								Men	Women	Both	

TABULATION OF TIME LOST

1			2				3					
No of employees			No of sick employees				Number of days lost through cases of sickness in each					
Men	Women	Both	Men	Women	Both	Department	Industrial Accident.	Non-Industrial Accident.	Sepsis	Tonsilitis	Bronchitis	Pleurisy
110	140	250	18	42	60	Offal	1 \ 2	3 \ 7	4 \ 3.7			
225	0	225	20	0	20	Killing			4 \ 20	3 \ 17	1 \ 9	
100	0	100	17	0	17	Cutting	1 \ 2		11 \ 98		1 \ 8	1 \ 9
100	0	100	10	0	10	Tanks & Fertilizer				2 \ 9		1 \ 6
82	0	82	15	0	15	Cellar			4 \ 19			
87	0	87	9	0	9	Cooler			1 \ 5		1 \ 5	2 \ 17
60	40	100	2	6	8	Sausage			2 \ 9	1 \ 7		
55	60	115	4	10	14	Oleo & Lard					4 \ 21	
16	26	42	0	17	17.	Canning	3 \ 3		1 \ 4		3 \ 11	
62	0	62	6	0	6	Pickling				1 \ 6		1 \ 7
36	20	56	0	8	8	Smoked Meats		2 \ 2			1 \ 7	
89	0	89	4	0	4	Shipping	1 \ 2					
70	0	70	6	0	6	Engineers & Helpers	2 \ 3	2 \ 6				
0	16	16	0	6	6	Laundry	2 \ 5					
110	90	200	1	2	3	Office						
1202	392	1594	112	91	203	Totals	10 \ 17	7 \ 15	27 \ 192	7 \ 39	11 \ 61	5 \ 39

Explanation.—The figures in the triangles within the squares represent the number of cases of sickness involved.

N. B.—The figures in this sample form are purely hypothetical, and do not refer to any particular plant.

THROUGH SICKNESS

Firm No. *37* Year[4] *1921* Month[5] *February*

Lumbago	Rheumatism	Colds	Dermatitis	Gastro-Enteritis	Diphtheria	General Debility	Total no of days lost in each occupation by all diseases	Total Absence: Total No of days lost in each occupation through sickness and all other causes — Men	Women	Both	Remarks: E. G. High proportion of:- (a) Workers of sub-normal physical or mental capacity (b) Married Women (c) Extremes of age (d) Foreigners
	3 / 7	6 / 9		39 / 195	4 / 99		60 / 356	22 / 120	46 / 249	68 / 369	High figures for Gastro-Enteritis due to numbers of foreigners upset by unaccustomed meat-eating
	3 / 7			6 / 21		3 / 7	20 / 81	22 / 83		22 / 83	
	2 / 7			1 / 7			17 / 131	20 / 134		20 / 134	Long absence from Sepsis, here and in offal dept. due to employees delay in reporting to dispensary
	2 / 6			3 / 10		2 / 2	10 / 33	10 / 33		10 / 33	
		4 / 8	7 / 19				15 / 46	15 / 46		15 / 46	
		4 / 7		1 / 3			9 / 37	10 / 38		10 / 38	
		3 / 4		1 / 4		1 / 4	8 / 28	2 / 7	8 / 23	10 / 30	
3 / 6	2 / 3		2 / 4			3 / 4	14 / 38	5 / 9	10 / 30	15 / 39	
		3 / 3				7 / 11	17 / 32	1 / 2	18 / 33	19 / 35	
				3 / 14		1 / 2	6 / 29	6 / 29		6 / 29	
		1 / 2		1 / 2	1 / 21	2 / 2	8 / 36	1 / 1	9 / 37	10 / 38	
		3 / 11					4 / 13	4 / 13		4 / 13	
2 / 4							6 / 13	7 / 16		7 / 16	
2 / 3		1 / 2				1 / 5	6 / 15		7 / 16	7 / 16	
		1 / 6				2 / 4	3 / 10	3 / 3	4 / 14	7 / 17	
7 / 13	12 / 30	26 / 52	9 / 23	55 / 256	5 / 120	22 / 41	203 / 898	128 / 534	102 / 402	230 / 936	

APPENDIX H.

WORKMEN'S COMPENSATION ACTS AND RELATED PROBLEMS

Workmen's Compensation

During recent years the principle of compensation of injured employees engaged in industrial pursuits has been adopted in many states and provinces under so-called workmen's compensation laws. This development is of much interest and importance to physicians because without his cooperation these measures could not be carried into effect. The American Association for Labor Legislation, a voluntary agency which has been active in promoting such legislation, has outlined the following features as being essential in workmen's compensation laws.

I. Scale of Compensation

Assuming machinery to insure the prompt payment of the compensation required by law, the scale of payments is the most important feature of the system. The strongest argument for compensation to all injured workmen or to their dependents is that shortened lives and maimed limbs due to industrial injuries are just as much expenses of production, which should be met by those conducting industry for their own profit, as are used-up raw materials or worn-out tools and machinery. The whole expense of losses to capital is necessarily borne by the employer. The whole expense of the personal losses due to injuries is the loss in wages sustained and the expenses for medical care during incapacity. The only logical reason for not imposing, through the employers, this entire expense on every industry that occasions it, is that injured workers must not be deprived of a motive for returning to work and to independent self-support as soon as they are able to do so. The compensation act, therefore, should provide for the expense of all necessary medical attendance and for the payment of such a proportion of wages to the victim of the injury

during his incapacity, or to his dependents, if he be killed, as will provide for the resulting needs and yet not encourage malingering. The following scale is believed to conform to these requirements and to be the lowest that should be inserted in any compensation law.

1. **Medical Attendance.**—Aside from humanitarian considerations the employer should, in the interest of economy and efficiency, be required to furnish all necessary medical, surgical and hospital services and supplies as determined by the Accident Board.

All of the acts except those of Alaska, Arizona and New Hampshire provide for medical attendance. In California, Connecticut, Hawaii, Kentucky, Maryland, Nebraska, North Dakota, Ohio, Oregon, Porto Rico, West Virginia and Wisconsin, and under the United States federal law for government employees, the period during which such services and supplies are to be furnished is left to the discretion of the Accident Board. In California, Colorado, Connecticut, Idaho, Indiana, Kentucky, Massachusetts, Michigan, Nevada, New York, North Dakota, Ohio, Oklahoma, Porto Rico, Rhode Island, Texas, Washington and Wisconsin, and under the federal law, this board controls the amount of such services and supplies. In Maine, Nebraska and Pennsylvania the amount payable may be increased in the discretion of the board in case a major surgical operation is required.

2. **Waiting Period.**—No compensation should be paid for a definite period—to be not less than three nor more than seven days—at the beginning of disability.

In California, Connecticut, Hawaii, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Missouri, Nebraska, Nevada, North Dakota, Ohio, Oklahoma, Texas, Utah, Vermont, Washington, West Virginia and Wisconsin, and under the federal law, the waiting period is as here recommended. In Oregon and Porto Rico there is no waiting period.

3. **Compensation for Total Disability.**—The disabled workman should receive during disability 66⅔ per cent of wages; compensation not to be more than $25 or less than $8 a week, unless his wages are less than $8 a week, in which case compensation should be the full amount of wages. If he is a minor, he should, after reaching twenty-one receive 66⅔ per cent of the wages of able-bodied men in the occupation group to which he belonged.

All of the acts except those of Alaska, Oregon, Washington, and Wyoming base the compensation on a percentage of wages, rather than on a flat rate regardless of the wages.

The percentage of wages here recommended is the same as in Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, New York, North Dakota and Ohio, and in the federal law. California, Illinois (sliding scale), Kentucky and Wisconsin provide 65 per cent, Alabama (sliding scale), Hawaii, Iowa, Kansas, Louisiana, Maine, Michigan, Nevada, Pennsylvania, Texas and Utah provide 60 per cent, while Idaho, Indiana and South Dakota provide 55 per cent.

In California, Colorado, Idaho, Illinois, Missouri, Montana, Nevada, New York, Ohio, South Dakota, Utah and West Virginia compensation for permanent total disability is allowed for life, and in Arizona, Maryland, Nebraska, North Dakota, Oregon and Washington, and under the federal law, compensation for total disability is payable during the continuance of the disability.

The fact that the injured employee is a minor is recognized in fixing compensation in California, Colorado, Connecticut, Illinois, Iowa, Maryland, Massachusetts, New York, North Dakota, Ohio, Oklahoma, Texas, Utah, and Wisconsin and under the federal law.

4. **Compensation for Partial Disability.**—The workman who is only partially disabled should receive a percentage of his wages proportioned to the degree of physical disability (taking into account age and occupation), and subject to readjustment only on account of changes in extent of disability; compensation not to exceed $25 a week, with provisions for minors, and for workmen earning less than $8 similar to those in the case of total disability.

In case of second injury, Minnesota, New York, Ohio, Oregon, Utah, and Wisconsin pay out of a special fund any compensation in excess of that for which the second injury by itself would make the employer liable.

5. **Compensation for Death.**—(1) Funeral expenses. The employer should be required to pay a sum not exceeding $150 for funeral expenses, in addition to any other compensation.

All the laws except those of Alaska, Arizona, Illinois, Kansas, Maine, Maryland, (in case decedent's estate is large enough to pay such expenses), Michigan, New Hampshire, Oklahoma (which cannot constitutionally compensate for death), Porto Rico, Rhode Island,

South Dakota, Texas and Virginia provide funeral expenses in all cases of death whether or not there are dependents. The maximum limit is $200 in Maine, Massachusetts, Michigan and Rhode Island, while Alaska, Illinois, Kansas, Ohio, South Dakota and Utah allow $150.

(2.) Compensation for Widow.—If living with a decedent at the time of his death, or if the dependent, the widow should be granted 35 per cent of his wages until her death or remarriage, with a lump sum on remarriage equal to two years' compensation.

The method for compensation for cases of death recommended in this and succeeding paragraphs is substantially the same as in Alabama, Delaware, Hawaii, Idaho, Louisiana, Minnesota, Nevada, New Jersey, New Mexico, New York, North Dakota, Pennsylvania, Tennessee and Vermont, and under the federal law. The provision for a lump sum payment to the widow on remarriage is adopted in Colorado, Maryland, Minnesota, Nevada, New York, North Dakota, Oregon, Pennsylvania, Washington and West Virginia.

(3.) Compensation for Widower.—If living with the decedent at the time of her death and dependent upon her support, the widower should receive 35 per cent of her wages, or a proportionate amount if his dependency is only partial, to be paid until his death or remarriage.

(4.) Compensation for Widow or Widower and Children.—In addition to the compensation provided for the widow and widower, 15 per cent should be allowed for each child under eighteen, not to exceed a total of 66⅔ per cent for the widow and children. Compensation on account of a child should cease when it dies, marries, or reaches the age of eighteen.

(5.) Compensation to Children if there be no Widow or Widower.—In case children are left without any surviving parent, 25 per cent should be paid for one child under eighteen, and 15 per cent for each additional such child, to be divided among such children, share and share alike, not exceeding a total of 66⅔ per cent. Compensation on account of any such child should cease when it dies, marries, or reaches the age of eighteen.

(6.) Compensation to Parents, Brothers, Sisters, Grandchildren and Grandparents if Dependent.—For such classes of dependents 25 per cent should be paid for one wholly dependent, and 15 per cent addi-

tional for each additional person wholly dependent, divided among such wholly dependent persons share and share alike, and the proportionate amount (to be determined by the Accident Board) if dependency is only partial, to be divided among the persons wholly or partially dependent according to the degree of dependency as determined by the Accident Board. These percentages should be paid in cases where there is no widow, widower, or child. In other cases members of this class should receive as much of these percentages as, when added to the total percentage payable to the widow or widower or child, will not exceed a total of 66⅔ per cent. Compensation to members of this class should be paid only during dependency.

(7.) Compensation for Alien Non-Resident Dependents.—Aliens should be placed on the same footing as other dependents.

In Hawaii, New Hampshire, New Jersey, and New Mexico alone are non-resident dependents expressly excluded from compensation. In Iowa, Michigan, Nevada, North Dakota, Texas, Utah and Wisconsin and, in part, in California, Colorado, Connecticut, Delaware, Georgia, Idaho, Kansas, Kentucky, Maine, Maryland, Montana, Nebraska, New York, Oklahoma, Oregon, Pennsylvania, Virginia, Washington, West Virginia, Wisconsin and Wyoming, they are expressly included. In other States they are apparently included in the absence of any reference to them.

(8.) Maximum and Minimum Compensation for Death.—The wages on which death compensation is based should be taken to be not more than $37.50 per week nor less than $12 per week; but the total amount of the weekly compensation should not be more than the actual wages.

(9.) Commutation of Periodical Compensation Payments.—If the beneficiary is, or is about to become, a non-resident of the United States, or if the monthly payments to the beneficiary are less than $5 a month, or if the Accident Board determines that it would be to the best interests of the beneficiary, the employer should be permitted to discharge his liability for future payments by the immediate payment of a lump sum equal to the present value of all the future payments computed at 4 per cent true discount, compounded annually. For this purpose the expectancy of life should be determined according to a suitable mortality table, and the probability of the happening of any contingency such as marriage

or the termination of disability, affecting the amount or duration of the compensation, should be disregarded.

Substantially similar provisions are found in nearly all states and in the federal law.

II. Employment to be Included

It is believed that sufficient progress has now been made in public education on the problem, and in the development of efficient and economical machinery for insuring the employer against his compensation liability, to justify the inclusion in the system of all employments. The only exception which should be made is of casual employees in the service of employers who have only such employees and who, therefore, cannot fairly be required to carry compensation insurance policies. Such policies, on payment of a small additional premium, are now drawn so as to embrace casual as well as regular employees. No serious burden is, therefore, entailed on employers, even of domestic servants, in making them liable to pay compensation to casual employees.

The principle of limiting the act to so-called "hazardous" employments is adopted only in Alaska, Arizona, Illinois, Kansas, Louisiana, Maryland, Montana, New Hampshire, New Mexico, New York, North Dakota, Oklahoma, Oregon, Washington and Wyoming, and in most of these states those in other employments may elect to come under compensation. The tendency is to regard all employments hazardous.

Farm labor and domestic service are excepted from the operation of the act in nearly all the states, either expressly or indirectly.

In Alaska, Delaware, Georgia, Kansas, Kentucky, New Mexico, Missouri, Ohio, Oklahoma, Porto Rico, Tennessee, Texas, Utah, Virginia, and Wyoming the operation of the act is limited to employers employing more than a certain number of employees, ranging from 2 to 10; and in Alabama, Colorado, Connecticut, Maine, Rhode Island, Vermont, and Wisconsin employers of less than a certain number are not subjected to abrogation of the defenses in case they refuse to elect compensation. In all other states there is no distinction as to the number of employees.

In Iowa, Maryland, New Hampshire and Washington the employees to be included are limited to persons engaged in the hazar-

dous part of the employment. In all other states persons engaged in clerical work as well as those engaged in manual work are included.

Casual employees are included in Alaska, Kansas, Louisiana, Michigan, New York and Oklahoma, and under the federal law.

III. Injuries to be Included

Compensation should be provided for all personal injuries in the course of employment, and death resulting therefrom within six years, but no compensation should be allowed where the injury is occasioned by the wilful intention of the employee to bring about the injury or death of himself or of another. The act should embrace occupational diseases which, when contracted in the course of employment, should be considered personal injuries for which compensation is payable.

The principle of limiting the time within which death must occur in order to form a basis for compensation is found in Alabama, Arizona, California, Colorado, Connecticut, Hawaii, Idaho, Kentucky, Louisiana, Maryland, Nebraska, New Mexico, North Dakota, Ohio, Pennsylvania, Porto Rico, Utah, Vermont, Virginia, and West Virginia, and in the federal law.

The principle of excepting injuries caused by the wilful intention of the employee is found in all states except Arizona, Connecticut, Illinois, Massachusetts, Michigan, Montana, Nebraska, New Hampshire and Wyoming.

Occupational diseases are included as personal injuries entitling the employee to compensation in California, Connecticut, Hawaii, Massachusetts, New York and Wisconsin, and in the federal law.

IV. Other Remedies than Those Provided by the Compensation Act

One of the weightiest arguments against the outworn system of employers' liability is that it causes vast sums to be frittered away in law suits that should be used in caring for the victim of accidents. To avoid this waste the compensation provided by the act should be *the exclusive remedy.* If the employer has been guilty of personal negligence, even going to the point of violating a safety statute, his punishment should be through a special action prosecuted by the state factory inspection bureau.

This is the law in Alaska, Connecticut, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Dakota, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Vermont, Virginia, Wisconsin, and Wyoming, except that in a few of these states if the employer fails to insure the payment of compensation the injured employee has the option of claiming compensation or of suing at law with the defenses removed.

V. Security for the Payment of Compensation Awards

The supreme tests of a compensation system are, first, the incentive provided for reducing accidents to the utmost, and second, the promptness and certainty with which compensation claims are met. The strongest incentive toward prevention results from imposing the whole expense of compensation upon the employer. The irregularity and uncertainty of accidents, however, make this policy inexpedient for small employers with limited financial resources. Security can only be attained through some system of insurance. Employers should, therefore, be required to insure their compensation liability.

Alabama, Alaska, Arizona, Kansas and Minnesota are the only states which do not require in some form or other the employer to secure the payment of compensation either by insurance or by the giving of a bond.

In accordance with the plans of insurance at present provided for, employers may either:

(1) Maintain their own insurance fund subject to the approval of the Accident Board or other administrative authority:

Massachusetts, Nevada, North Dakota, Oregon, Porto Rico, Texas, Washington and Wyoming do not permit employers to carry their own insurance.

(2) Insure in a Mutual Association authorized to insure compensation liability:

Insurance in a mutual association is permitted in most states, including California, Colorado, Connecticut, Delaware, Georgia, Hawaii, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New

Mexico, New York, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Tennessee, Texas, Utah, Virginia, and Wisconsin.

(3) Insure in a State Insurance Fund managed by the Accident Board upon the same principles and subject to the same general requirements as those governing Mutual Insurance Associations:

State insurance is authorized in California, Colorado, Idaho, Maryland, Michigan, Montana, Nevada, New York, North Dakota, Ohio, Oregon, Pennsylvania, Porto Rico, Utah, Washington, West Virginia and Wyoming.

(4) Insure in a commercial company, such companies to be subjected to the most rigid regulation to guard against insolvency, to insure just settlement of claims, to prevent wasteful practices and exorbitant rates, and to eliminate unfair competitive methods.

Insurance in commercial companies is not allowed in Nevada, North Dakota, Ohio, Oregon, Porto Rico, Washington, West Virginia, and Wyoming, and sentiment is rapidly developing in favor of such exclusion elsewhere.

VI. Organization of Accident Board

It is essential to the successful operation of the compensation system that an Accident Board be created. This board should consist of 3 or 5 members appointed by the governor with the consent of the senate. The board should have power to employ necessary assistants. Its members should be required to devote their entire time to its work and should not be permitted to carry on any other business or profession for profit. The entire cost of administration of the accident board, including the administrative expenses of establishing the state insurance fund managed by the accident board, should be paid out of an appropriation made by the state.

Accident boards are provided in all the states except Alabama, Alaska, Arizona, Kansas, Louisiana, Minnesota, New Hampshire, New Mexico, Rhode Island, Tennessee and Wyoming.

VII. Procedure for Settlement of Compensation Claims

Provision should be made for the determination of all claims for compensation either by the accident board, or, if the number of claims be large, by one member of the board or an authorized deputy. A

decision by a member or deputy should be conclusive, unless appeal therefrom is taken to the entire accident board within a specified time. The accident board's disposition of the case should be final and conclusive unless appeal therefrom is taken within a specified time. Appeals from decrees of the accident board should not be allowed, except on questions of law, and should be carried direct to the highest court.

The procedure here recommended was adopted in New York by amendment of the law in 1919 after an investigation which showed frequent and large underpayments of compensation resulting from an earlier amendment permitting direct settlements.

VIII. Reports of Accidents

The bill should contain provisions similar to those of the Standard Accident Reporting Bill of the American Association of Labor Legislation, now in use for about half the industrial population of the country, requiring full and accurate reports of all industrial accidents as a basis for computation of future industrial accident rates and for future safety regulations to decrease or prevent accidents.

IX. Rehabilitation

Restored earning power is of more importance than distress relieved. The administrative board should therefore, be authorized to encourage, cooperate with, or conduct enterprises for the re-education and rehabilitation of injured persons.

More than twenty states have already made provision for aiding industrial cripples to secure retraining, reeducation or reemployment.

APPENDIX I

HOUSING—GENERAL, LODGING HOUSES AND CAMPS

It is appropriate to consider very briefly the question of housing in relation to preventive medicine at this point because the present situation in housing has arisen largely as the result of the industrial revolution which also gave rise to the problems of industrial hygiene.

Housing and town planning should really be considered together since the solution of the problem of providing minimal standards in housing should follow the development of a satisfactory scheme of town planning. Unfortunately this is frequently impossible, and the best must be made of a bad situation. Where slum dwellings of the tenement type or dilapidated shacks exist in certain areas of otherwise desirable towns, their removal or replacement may be possible when to start from the beginning with a town planning project in the same community might not be feasible.

It is generally accepted that higher death rates, more sickness, poverty, misery and distress is seen among those whose economic status necessitates their living in unsuitable habitations and often in an unfavorable environment.

In many Cities in Great Britain, investigations have revealed marked differences in the death rate among those living in houses containing one room and those living in houses containing more than one. The findings of Chalmers of Glasgow illustrate this point. Somewhat more than 60 per cent of the population of that city live in one- or two-roomed dwellings, in tenements. The mortality rate among those living under such conditions is as follows:

	Death Rate
One roomed houses	25.9 per 1,000
Two " "	16.5 " 1,000
Three " "	11.5 " 1,000
Four " "	10.8 " 1,000
	(Robertson)

Robertson has shown in Birmingham, England, that there is a

striking contrast in different parts of the same city in the matter of death rate, etc., if a slum area is compared with a section of the municipality where reasonably satisfactory housing conditions exist. These are shown in the accompanying table.

TABLE XCIX

DEATH RATES, ETC., IN DIFFERENT AREAS OF BIRMINGHAM, ENGLAND (5 YEAR PERIOD) (Robertson)

	BAD AREA	FAIR AREA
Population	154,662	133,623
Area (in acres)	1,921	2,998
Death rate	21.1	12.3
Birth rate	32.8	24.0
Infant Mortality rate	171	89
Deaths from pulmonary tuberculosis	1,511	742
Pulmonary tuberculosis death rate	1.93	1.11
Deaths from measles	647	161
Measles death rate	0.83	0.24
Deaths from diarrhea and enteritis	1,126	238
Diarrhea and enteritis death rate	1.46	0.36

In connection with these figures Robertson emphasizes the point that "it is well to bear in mind that they would have been worse but for the fact that every year even into the slummiest areas of our towns, there is a considerable migration of healthy country stock which, being more resistant to disease than is the slum dweller, prevents the figures from mounting so high as they would otherwise have done."

It is of course, necessary to appreciate the fact that bad housing is the result in the case of the majority of persons of an unfavorable economic condition. This may be due to any one or more of a great variety of causes. So that housing alone is not responsible for sickness and death. What it may reasonably be held accountable for, among poor persons, often ignorant and struggling against most unfavorable circumstances, is intense exposure to infections, malnourishment and the evil consequences of unfavorable environmental conditions. All these favor disease development, and increase misery and suffering and destitution. Therefore, improvements in housing and in the surroundings will inevitably exercise a favorable influence on the health and well being of those whose status is thus raised.

The requirements of the dwelling environment, etc., have been set forth by Robertson under the following heads:

(A) **The Dwelling—**

(1) The dwelling must be weather-proof.

(2) It must protect against extremes of temperature.

(3) It must be dry, not only in its walls and roof, but also—and this is more important still—in its floor.

(4) The internal structure must be such as to enable it to be kept clean.

(5) The size should be proportionate to the number of people occupying it, so as to prevent overcrowding.

(6) It should have adequate sunlight and efficient ventilation.

(7) The internal arrangements should be such as to lessen housework.

(8) It should have a sufficient water supply, and in the case of town houses this should be laid in inside.

(9) It should be provided with a bath.

(B) **The Environment—**

(1) The house and garden or yard should be self-contained.

(2) The area allotted to each dwelling must be sufficient to permit of free circulation of air and direct access of sunlight.

(3) Either inside the dwelling or immediately adjoining outside there must be a water-closet, together with adequate drainage arrangements to carry off all liquid organic matter.

(4) Provision must be made for the storage and frequent removal of solid refuse.

(5) Facilities must be provided for the home washing and drying of clothes.

(6) Provision must be made to prevent soakage of filth into the ground in the immediate vicinity of the house.

(C) **General Provisions—**

(1) The house should have a good general amenity in its surroundings.

(2) The area in which it is erected should be free from soot or grit in the air, or effluvium, or noise, or nuisances from factories.

(3) There should be in the immediate neighborhood sufficient transportation facilities.

(4) Provision is necessary for the recreation of the occupants in the open air, and for institutes.

(5) Provision should be made for gardens, allotments, etc., and for the general beautifying of the environment by tree planting, etc.

In connection with town planning the essential points are that any project should provide for proper sanitary conditions, etc., adequate transportation facilities, the segregation of factories and business premises at a distance from residential areas; regulation of the number of dwellings per acre of land; (preferably not more than 12) and other matters of importance to those living in the community.

For a more detailed discussion of these subjects of housing and town planning the reader is referred to books devoted especially to them, certain of which are indicated in the list at the end of this section.

In addition to the problems of housing which are acute in large centers of population and especially in industrial centers, there are also problems which arise in connection with lodging houses and lumber and mining camps. The difficulties are essentially those of insuring a clean sanitary habitation and decent environment for those persons who are not members of a family occupying a single habitation.

Suitable water supply, sewage disposal, adequate lighting, ventilation and heating and sufficient cubic space for each dweller must be provided. This is usually required by public health law or regulation and the following extracts will suffice to indicate the nature of such requirements.

Extracts from regulations governing lodging houses under the Public Health Act of New Brunswick promulgated by the Minister of Health of that Province.

(28) The expression "Lodging Houses" shall mean any house in which sleeping accommodation is let to transient lodgers, two or more of whom not being of the same family or party, occupy a room in common; or, any individual house declared to be a lodging house by the subdistrict Board of Health, in the subdistrict of which such house is situated.

(29) A keeper of a lodging house shall not receive, nor suffer to be received into such house, or into any room therein, a greater number of lodgers than shall be fixed by said subdistrict board concerned, which number, both as regards the total number to be admitted to the house, and to each room severally, shall be specified

to each keeper by the said board coincident with the granting of a license, and such specification shall continue in force until in the opinion of the said board, it may be necessary to decrease it, or until, if circumstances warrant, the number shall be enlarged.

Said keeper shall not permit any room in such house to be used as a sleeping apartment if the floor of such room is below the level of the surface of the foot-way of the adjoining street or road, or of the ground adjoining or nearest to such room.

(30) Such keeper shall not, except in cases as are hereinafter specified, cause or suffer any person of the male sex above the age of ten years to use or occupy any room which is used or occupied as a sleeping apartment by persons of the female sex; or any room by any person of the female sex which is occupied by persons of the male sex above the age of ten years; provided that this regulation shall not be taken to prohibit the use and occupation by a husband and wife of any room which is not used or occupied by any other person of either sex above the age of ten years.

Such keeper shall cause every yard or other open space within curtilage of the premises, to be maintained in good order and to be thoroughly cleaned as often as may be necessary for the purpose of keeping such places in a clean and wholesome condition, and so as to avoid the formation of a nuisance.

Such keeper shall cause the floor of every room and passage and stairway in such house to be thoroughly swept at least once in every day, before the hour of ten in the forenoon, and to be thoroughly washed at least once in every week, and the windows, fittings and painted surfaces to be thoroughly cleaned as often as may be necessary.

(31) Such keeper shall cause all bed clothes and bedding and every bedstead used in such house to be thoroughly cleansed as often as shall be requisite for the keeping of such furnishings in a clean and wholesome condition.

(32) Such keeper shall provide for the use of the lodgers an adequate supply of water-basins and towels. He shall cause the basins to be kept clean and the supply of towels to be renewed as often as may be necessary. He shall cause all solid and liquid filth to be removed at least once in every day before ten o'clock in the forenoon from every room in such house, and shall cause all receptacles for such filth to be thoroughly cleansed. He shall also keep the seat,

floor, and walls of every water-closet and privy belonging to such house in a cleanly condition, and shall cause every water-closet and privy to be maintained in good order and efficient action.

(33) Such keeper shall cause all such means of ventilation as may be provided in connection with such house to be maintained in good order and efficient action, and shall cause every window in such sleeping apartment to be kept open for at least one hour each day, except when the state of the weather prohibits it, or in consequence of sick persons in such room.

(34) Such keeper shall cause the bed clothing of every bed in such house to be removed from such bed as soon as it conveniently may be after such bed is vacated, once in each day, and shall cause such bed clothes to be freely exposed to the air at least one hour, each day.

(35) Such keeper immediately after he shall have ascertained that any lodger in such house is sick of any notifiable disease, or suspects such to be the fact, shall notify the subdistrict board concerned of such fact, or suspicion and shall not permit any person, not already therein, to enter or occupy the room where such sick lodger may be, except the medical attendant or clergyman until he shall have received instructions relative thereto, from the district medical health officer concerned, or other qualified public health official, which instructions he shall at once proceed to carry out, and if such sickness be pronounced by said official to be a notifiable kind or be strongly suspected to be such, such room in which such sickness occurred shall not be reoccupied for two days after being vacated by the removal or death of such lodger, nor until two days after all the necessary precautions for the prevention of the spread of such disease prescribed by the said district medical health officer, or other such official shall have been completely carried out.

(36) Such keeper shall not cause or suffer any room in such house appointed to be used as a kitchen or eating-room, to be used or occupied as a sleeping apartment, or suffer food to be kept or eaten in any sleeping apartment of such houses, unless in the case of the sickness of any such lodger, in such apartment.

(37) Such keeper shall not cause nor suffer any bed in any room in such house to be occupied at any time by more than one person of the male sex above the age of ten years, nor cause nor suffer any lodger to occupy any bed in such house at any time within the period of eight hours after such bed has been vacated by the last

preceding occupant, and he shall cause every room in such house to be furnished with such number of beds and bedsteads and such a supply of bed clothing as may be sufficient for the requirements of the number of lodgers permitted to be received in each such room.

(38) Such keeper upon receiving from the subdistrict board concerned, a notice or placard wherein shall be stated the maximum number of lodgers authorized to be received at any one time in such designated room of such house, shall affix such notice or placard to a conspicuous place in such room, so that it may be distinctly visible and the words and figures thereon easily read. He shall keep such placard constantly so posted, and shall not suffer it to be willfully or carelessly defaced. He shall be furnished with such notices or placards by said board, and, if considered necessary by the latter, a printed copy of these regulations relating to lodging houses shall be conspicuously posted in each room of such house.

(39) No person shall keep a lodging house until duly licensed so to do by the subdistrict board concerned, nor shall any such license be issued by said board until the house proposed as a lodging house shall have been declared by the chief inspector of said board, or some other competent official authorized by the board so to do, with the approval of the district medical health officer concerned, to be suitable for the purpose of a common lodging house, and shall have paid to the board a license fee of two ($2) dollars. Such license shall be valid for a period of one year from the date of issue, or as much of it as shall have unexpired between such date and the first day of May, next following.

Such license shall be liable to revocation at any time by the board issuing it, because of failure on the part of said keeper to carry out these regulations with respect to lodging houses, or for any other reason that shall appear just and expedient to the board. Such license shall be renewable from year to year in the discretion of the board, upon payment of a fee equal to that primarily paid.

Regulations (August, 1912) governing housing and environmental conditions in camps, etc., in Ontario as set forth under the Public Health Act: (Amended 1921 to include specifications, details, and plans of camp construction.)

Site of Camp, Buildings, etc., to be Approved by Inspector.—

11. The location of the buildings of any camp or works shall be made with a due regard to its healthfulness, and any new camp or

works located without the previous approval of the inspector or officer of the Provincial Board must, if the site is found to be undrained, unhealthy, or wanting in any adequate or wholesome water supply, be moved to a proper location; and any old camp, works or dwelling, if proved unsanitary or unhealthy shall be made satisfactory to the aforesaid inspector or officer.

No camp shall be erected nearer than 100 feet to any lake, stream or other water.

All bunks must be constructed parallel with the wall of the building to prevent overcrowding.

The lower tier of bunks shall be raised at least one foot from the floor, and the floor shall extend completely to the wall.

Provisions as to Air Space, Lighting, etc.—

12. Any house, tent or dwelling occupied by the employees engaged in any industry in any territory without municipal organization shall contain 600 cubic feet of air space for every occupant thereof, and shall further be provided with sufficient means of ventilation. The floor of every dwelling shall be constructed of boards or planks, or other material equally suitable for the purpose, raised on supports at least one foot from the ground, and so made that it shall be tight. Every such dwelling, other than a temporary tent, not exceeding 10 by 15 feet, shall be supplied with adequate lighting, and in all wooden or iron structures the windows must be constructed that they can be opened when necessary.

Method of Ventilation to be Approved.—

13. The method of ventilation of every dwelling in which a stove or furnace is used, shall be such as will satisfy the inspector or officer of the provincial board. The temperature of the room should be maintained at 65° F., and a shallow pan supplied with water shall be kept on the stove to supply air moisture.

Wash-house, Laundry and Bath.—

14. Every camp or the works of any industry coming under these regulations shall be equipped with a separate building to be used as a wash-house or laundry, and attached thereto a room, or, if preferred, a separate building or tent equipped with a stove and tubs for bath purposes in a manner satisfactory to the inspector or officer of the provincial board.

Separate Kitchen with Dining Room to be Provided.—

15. Every camp or works shall be supplied with a building or tent properly constructed and set apart as a kitchen or cook-house, and having a dining room in connection therewith, with proper conveniences for the cleanliness and comfort of the employees, and must be satisfactory to the inspector or officer of the Provincial Board.

Refuse to be Collected and Removed in Buckets.—

16. Proper buckets shall always be kept on hand into which all refuse, whether liquid or solid, can be placed; and the refuse must regularly be removed to a safe distance from the kitchen, and be so deposited as not to create a nuisance or contaminate the drinking water. A properly constructed drainage system satisfactory to the aforesaid inspector or officer may be utilized in lieu of slop buckets.

Latrines or Earth Closets to be Kept Clean.—Latrines, earth and other closets located to the satisfaction of the physician employed, and to the inspector or officer of the provincial board, shall be constructed at every camp or works, and must be located and maintained in a sanitary condition satisfactory to the medical officer of the works and to the aforesaid inspector or officer.

Stables Not to be Less than 125 Feet Distant from Kitchen, etc.—

18. The stables in connection with any works or camp must be so located as not to contaminate the water supply, or drain to any water; they must not be less than 125 feet distant from any dwelling or kitchen. In large camps this distance may be increased if thought necessary by the aforesaid inspector or officer.

In Mines of 100 Feet in Depth, Portable Privies Are Required.—

19. In mines of a depth of 100 feet or over, or with drifts of 300 feet or over, portable closets satisfactory to the provincial board for the use of employees are required.

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APPENDIX J

ORGANIZATION AND CONDUCT OF PUBLIC HEALTH CENTERS OR CLINICS FOR MATERNAL AND CHILD WELFARE WORK

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Elsewhere in this volume the subjects of infant mortality and morbidity have been thoroughly discussed. In this article we propose to elaborate a practical scheme for the solution, so far as possible, of the problems there presented.

For many years back efforts by individuals and organizations, working each along definite and specialized lines, have been made, endeavoring to improve the conditions of the infant and the growing child, but only recently have these efforts been organized and coordinated into a general system to which the broad term "Child Welfare" has been applied.

Child Welfare may be considered in three phases determined by the time in the life of the infant at which it is applied; viz.,

(1) The care of the unborn infant, referred to as antenatal care.

(2) The care of the infant during and immediately after birth. (The obstetrical technic and delivery.)

(3) Postnatal care.

There are further, two distinct aspects to child welfare:

(1) The medical aspect of child welfare—more properly called "Child Hygiene."

(2) The social aspect—having to do with the general social and domestic conditions of the child.

These various points must be considered in any general scheme of "Child Welfare."

Antenatal Care

At the present stage of medical education it may be accepted without argument or proof that efficient antenatal care is a very important determining factor in the birth at full term of a healthy infant. In a definition of antenatal care Adair has said: "Prenatal care is that part of a public health program which has as an ultimate object the influencing of the health of the offspring beneficially by surrounding the mother with proper conditions during the period of her pregnancy."

Obstetrical Care

As to efficient obstetrical care at the time of delivery, little need be said as every medical practitioner and nurse has seen sufficient to realize its importance.

Statistics at the Burnside Hospital, Toronto, and other large maternity hospitals demonstrate the results to be obtained from efficient prenatal and obstetrical care, the results of which are:

(1) Lowering of infant mortality.

(2) Lessening of morbidity.

(3) Delivery of a healthy child.

(4) Leaving a mother in a condition fit and able to care for her child and to nurse it.

In the antenatal period the attention is devoted to the mother; in the stage of delivery, to the mother and infant; and in the postnatal stage, to the baby. The first two periods are carried on in the field of obstetrics—the third in the field of pediatrics, and it is in this stage that the work of child welfare proper is carried on. This is the period during which the growth and development of the child is observed and measures advised to correct remediable congenital defects or to avert the development of conditions of ill-health that may arise through ignorance, poverty, or neglect on the part of those in charge of the child.

Organization

In the Province of Ontario there is now a division of the Provincial Board of Health under which the physical care of maternity, infancy, and childhood is supervised and under which provision is made for the introduction and organization of antenatal care and child welfare in centers throughout the Province.

.In considering the working scheme of Child Welfare we shall group the agencies under two main divisions; viz.,

(1) The executive or central body.

(2) The administrative body.

The duties of the executive body are:

(1) To carry on propaganda stimulating an interest in the work.

(2) To properly introduce and inaugurate the work in a given center.

(3) To compile statistics and publish literature dealing with interesting topics in connection with the work.

The duties of the administrative body are:

(1) To assist in stimulating interest in the work.

(2) To assist in the introduction and inauguration of the work.

(3) To arrange for provision of suitable agencies for follow-up and continuation.

(4) To carry on in detail the complete scheme in the territory of which they form the center.

The formulating of the general scheme is in the hands of the executive. The detailed administration of the scheme is in the hands of the local committee by whom the general plan may be worked out to suit the needs of the individual community. The executive body may be composed, as in the Province of Ontario, as follows:

At the head there is the Provincial Board of Health with its various divisions, the one having to do especially with the antenatal and child welfare work being the "Maternal and Child Welfare Division." This division is officered as follows: (1) Director, (2) Assistant Director, (3) Supervisor of Nurses, (4) Clerical (two) assistants, (5) A Pediatrician, (6) A Consultant in Pediatrics, (7) A Consultant in Obstetrics. In addition to these there are likewise attached sixteen public health nurses who are sent in pairs to centers in the eight health districts of the Province to demonstrate in various ways the value of public health education generally, also to describe correct food, clothing and hygienic conditions for children and antenatal care for expectant mothers. The work of these nurses forms a very important section in the introduction of the general scheme to a community.

Publicity

It is advisable to prepare the way for this preliminary nursing service by publishing health articles written by some competent person in the local papers, in addition to brief display topics in the news sections of these papers. Further publicity is obtained by securing the cooperation of local organizations, and by holding one or two general meetings to which the public is invited and in which the purposes of the organization and the need for it are explained. At this point all the local agencies are organized into one general child welfare committee to carry on the work in the district.

As soon as the publicity program has awakened sufficient interest to justify the work being started, the nurses from the department enter the district on invitation of the local medical officer of health. They proceed to make a survey which includes the birth rate, infant mortality, feeding methods and nutritional condition of the children of pre-school age. On the completion of this survey they are ready to present a report showing the specific conditions of the district. After the survey has been completed with the cooperation of the local physicians, nurses and social service or other organizations whose interest may have been aroused, the pediatrician from the department attends to open a child welfare clinic at the center. The aim is to start the child welfare clinic in each center on a uniform basis. The staff at the clinic should consist of a physician with some knowledge of infancy and infant feeding, two public health nurses or one public health nurse and a voluntary assistant, also a clerical assistant and one or two voluntary workers from the organization that has been specially active in assisting in the introduction of the work in that particular community.

Operation of Clinic

On the first visit to the clinic a child is weighed and measured, its feeding history is noted and it is given a thorough physical examination by the physician in charge. Physical or mental defects where found, are noted and errors in feeding are corrected. Breast feeding is stressed as the infant's best food, failing which cow's milk modifications are advised and patent foods are unreservedly condemned. Feeding correction is the main object of the clinic and not medical treatment. Wherever defects are found or treatment

is indicated beyond the correction of feeding, the child is referred for direction to the family physician as under no circumstances is it permitted to administer medical treatment at a child welfare clinic. Infants suffering from severe nutrition disturbances should always be referred to their physician.

The purpose of the clinic is to keep well babies well. The curing of sick infants is the work of the medical practitioner. At the clinic a duplicate copy of the instructions is made, one for the guidance of the mother, the second for the nurse and during the days following the clinic, the nurse visits the babies in their homes in order to see that the instructions given the mother by the clinic physician have been understood and are being carried out. After the examination is completed and the instructions thoroughly explained to the mother by the clinic physician, it is advised that the child be brought at regular intervals of one or two weeks to the clinic so that progress notes of its development may be made and the instructions originally given varied as may be indicated from time to time.

The premises for the clinic should be one large room comfortably warm, part of which may be screened off for making the examinations with sufficient toilet and lavatory accommodation. The special equipment for the clinic should consist of a reliable set of scales weighing pounds and ounces, an examining table provided with suitable pads, a correct tape measure, a liberal supply of paper napkins and a second table for writing, together with tongue depressors and ear speculum. The clinic premises should be made attractive, interesting, and instructive, and any decoration of the walls should be with this in view. Health posters and mottoes may be easily obtained, combining all three features indicated above. In this way we visualize the ideas contained in the verbal instructions and secure a deeper impression. The personnel of the clinic staff may be selected in two ways, depending on the district.

(1) In a city, especially with university connection, the medical officer of health in cooperation with the Professor of diseases of children, appoints a director of child welfare, a superintendent of public health nurses and a supervisor.

The director of child welfare appoints the clinic physicians and is in control of the physician's aspect of the work. In this connection special mention should be made of the value to the child welfare clinic of connection with a children's hospital or a general

hospital with an active children's department, where special courses in pediatrics are given for practitioners and where cases requiring special investigation may be referred.

The superintendent of nurses appoints all public health nurses and is in general control of the nursing situation. The supervisor of child welfare looks after securing satisfactory clinic premises, equipping same, and is in control of all details of the center which concerns the public health nurse.

(2) In a town or rural district the usual procedure is as follows: In selecting a clinic physician the local practitioners meet in conference and select from among their number the man who seems best qualified to carry on the work. As a rule the physician so chosen endeavors to qualify still further by postgraduate work in pediatrics.

The selection of a public health nurse for the district may be made in one of three ways; viz.,

1. By the municipal council.
2. By a voluntary organization which is making itself responsible for financing the scheme in the district.
3. By the state and provincial health department on the request of either of the first two. The nurse should select the workers for the clinic and in this exceptional tact should be exercised, as she is dealing mainly with voluntary workers. The clinic premises, equipment and nurse's salary are financed either by the municipal council or the general committee aided by a grant from the council.

ORGANIZATION AND CONDUCT OF TUBERCULOSIS PUBLIC HEALTH CLINICS

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Introduction

The organization of the clinic should be carried out in such a manner as to meet the various demands which the diagnosis and supervision of the tuberculous necessitate, and, at the same time, encourage the fullest cooperation with the various official or volun-

tary departments dealing with the different problems associated with those suffering from tuberculosis, or suspected thereof.

For two particular reasons it is advisable to use the phrase "chest clinic" rather than tuberculosis clinic. The elimination of the latter will encourage many individuals to attend who otherwise might hesitate owing to the fear of, or the stigmata attached to, the word tuberculosis. In an attendance thus unfettered there will be included not only the truly tuberculous, who are perhaps nervous and suspicious of their true condition, but as well, examples of different types of nontuberculous pulmonary diseases which will provide the clinic with an opportunity for differential diagnosis in diseases of the lower respiratory system.

That the so-called tuberculosis specialist needs this type of experience as well as a very thorough knowledge of at least the diagnostic aspects of general internal medicine, there is only too abundant proof. The sanatorium physician thinks that our consultants in medicine, or internists, too frequently overlook or wrongly diagnose early cases of tuberculosis—because the sanatoria do not very often get early cases, and the histories of most cases arriving there as advanced or frank cases would indicate that the diagnosis should have been achieved much earlier. On the other hand the internist is inclined to doubt the diagnosis of the specialist if the lesion is not frankly positive because he in turn finds in the cases returned from sanatoria other medical conditions which, whether or not the case is one of clinical tuberculosis, should have been diagnosed and treated.

If one might venture an explanation regarding the insufficiency of each type of training and experience, one might say that the internist, when he fails, does so because he does not realize how many are the types of positive tuberculosis and the varied clinical courses they may pursue. Consequently he fails to obtain the clue in the history by which the correct interpretation of the clinical observations and physical signs should be made. It is more often to this and lack of care, rather than to faulty technic in making the physical examination, that errors are to be ascribed. In contrast the sanatorium worker in so thoroughly realizing the many types of clinical tuberculosis and its varied clinical manifestations, is inclined to overlook other pathological conditions equally capa-

ble of producing or participating in the syndrome in the individual case.

The compromise would seem to lie in the provision of an opportunity for regional differential diagnosis and in emphasizing the need for a thorough knowledge of general medicine, at least in so far as its diagnostic aspects are concerned.

To some extent the detail of the organization of a chest clinic will depend upon its size and the environment in which it is held. The most satisfactory location is as one of the outdoor clinics of a large general hospital, so that it may share the many essential advantages by cooperation with a well-equipped x-ray laboratory, other clinics, observation bed wards, the surgical division and the different scientific laboratories. The establishment of a tuberculosis clinic as an entity apart from a general institution is prejudicial inasmuch as it burdens the clinic with the cost of maintaining various medical accessories which can better or more economically be obtained by cooperation with these departments in a general hospital. In this connection it is very questionable on the grounds of economy and efficiency whether tuberculosis clinics should be established in any but the larger centers: for the smaller towns, periodical visits by one of the staff of a chest clinic would serve to differentiate between those cases which could be simply disposed of, and those which should attend a proper clinic where the required diagnostic investigation could be carried out. However, no matter where the clinic is established there is a large minimum, below which it is impossible to operate without seriously crippling the service it *should* render the individual and the public health in general.

Part 1. Organization

In the first place the clinic rooms proper should have good light, but they must afford quietness so that a careful physical examination can be made, and a thorough history taken without interruptions. For even the smallest clinic the physical examination should almost necessarily be made in a room separate from that in which the history is taken and the initial clinical observation made of temperature, pulse, respiration and weight. This forms the initial step. From this stage on the clinic should itself provide or cooperate with other departments for additional types of examination.

Means for examination of the upper respiratory passages, sinuses, teeth, etc., have to be available not only for the detection of possibly tuberculous, but for nontuberculous foci of infection as well. The initial "chest examination" will frequently have to be reinforced upon by a general type of overhauling whether this is done at the time or referred to a general medical clinic for this purpose. In this connection disturbances of thyroid metabolism will in particular have to be fairly frequently eliminated by general clinical observations and basal metabolism determinations or the Goetsch test. This latter should be carried out while the patient is composed and at rest, which introduces the question of observation beds. There will always be a certain percentage among the applicants for diagnosis for whom rather intensive clinical observation will be necessary, if a correct diagnosis or exclusion of tuberculosis is to be made. It would seem more logical for the staff of the clinic to supplement the work already accomplished in the clinic by carrying on with the bedside observations rather than refer the suspect case to the observation beds of a sanatorium—and in the end it is more economical. However accomplished, observation beds there must be, whether these be in the wards of the sanatorium, in the general hospital and as such reserved or not for the clinic, or in the patient's own home.

No clinic for tuberculosis can today operate without utilizing a well-equipped x-ray department, which should be under the direction of a physician specially trained for this work. This direction does not for a moment suggest that the technical detail of the department should not be carried out by a lay technician. In fact the best results can often be achieved by such an arrangement, but a lay technician is not qualified to "read" or interpret the plates. Whether or not the x-ray laboratory is part of the clinic or a separate department under an experienced radiologist, the clinician should learn to examine and interpret his own plates. The reason lies in the fact that on many points clinically important in the individual case the stereoscopic plate findings will be helpful when taken into consideration with other data, but by themselves may not be decisive. A physician trained as a radiologist is or should be cognizant of this; the expert lay technician cannot be. The at-first-sight simple problem of interpreting the varying shadows as evidences of clinical tuberculosis may be extremely difficult even

though they are positively indicative of a pathological lesion. In my opinion the profession should refuse to patronize x-ray laboratories under lay direction because of the need of curtailing the harm that will—already has—resulted from diagnosis made on the basis of the x-ray examination alone. In short the clinician must learn to look upon the fluoroscopic examination and stereoscopic plates as additional and valuable aids in the thorough investigation of his case, counting himself fortunate if he has for counsel and cooperation an expert colleague in the director of the x-ray department.

Laboratory

The absolutely essential test is still the examination of the sputum for the presence or absence of the B. tuberculosis whether this be by means of the glass slide, or, in selected cases, by guinea pig inoculation. The municipal and provincial health laboratories supply bottles and containers and will forward a report free of charge, but excellent as is their service, it will be found more satisfactory if these facilities are available within the clinic.

For any but the smaller clinics there will be a considerable number of borderline cases in which despite careful examination, observation in the clinic, and cooperation with other medical departments including the x-ray, one will be unable to satisfy oneself whether or not there is clinically a tuberculous lesion. One will feel the need in these cases of additional diagnostic aids such as may be supplied by the experienced use of tuberculin and the different serological tests; namely, the tuberculo-complement-fixation reaction, the inhibiteur reaction of Calmette and the inhibitive reaction of Caulfield.

If tuberculin is to be used in following the course of the case, or as a therapeutic measure, suitable means must be at hand for making accurate dilutions. If serological tests or any but the simplest bacteriological investigations are contemplated, the laboratory must be in charge of an experienced serologist or bacteriologist.

Without a laboratory division a chest clinic can undoubtedly carry on and perform good and consistent work of a very high grade, but as regards the doubtful cases, the diagnosis can only be one of opinion and, if correct, based more upon clinical acumen, and to but a slight extent upon data. In many ways such a clinic will

be "marking time." However, it is better that this marking of time should be well done than that more should be attempted by adding a laboratory division to a clinic which is without sufficient clinical facilities to warrant or sufficient means properly to maintain this, comparatively speaking, expensive division. For the larger cities, especially those with large medical schools, it is almost inexcusable to attempt to run a modern chest clinic without a laboratory division.

Part 2. After-Care of the Tuberculous

After-care or follow-up work may be regarded as the method of disposal and supervision which should be carried out for each case. In order that, at the outset, the problems assembled under this heading may be viewed comprehensively, the accompanying classification (Table XCIX) of clinic cases is suggested together with the agencies desirable for their solution.

Certain aspects of the follow-up work can be presented more conveniently if taken up under the four clinical classifications therein given.

Class I. Following the definite diagnosis of clinical tuberculosis, admission to a sanatorium should nearly always be advised. As it is both impracticable and impossible—neither is it desirable—to keep all these cases in a sanatorium until their disease is arrested, the clinic should be advised when they are discharged. This notification should contain a short summary of the clinical course of the case while in residence, particular attention being paid to the cause of any periods of exacerbation requiring confinement to bed, and the maximum work capacity attained. In this way an unbroken survey of the disease in each case will be available from the time of the initial diagnosis; and in consequence the supervision by the clinic can be resumed with the maximum of benefit for the patient. Speaking approximately, the supervision will vary according to the work capacity which on medical grounds is advisable for each case. On this basis of work tolerance or capacity the cases will be:

(a) Confined to their home on absolute or partial rest with one or more hours of occupational therapy.

(b) On partial rest with part-time employment which may take the form of occupation in some type of sheltered work, if this is

TABLE C

AFTER-CARE

CLINICAL CLASSIFICATION	TYPES OF DISPOSAL AND SUPERVISION
I. Clinically tuberculous (synonyms — frankly or positively tuberculous, open cases, etc.). Will include a small percentage of cases in which the pathological lesion is subminimal in extent or doubtful in character.	(a) Initial and possibly repeated admission to sanatorium. (b) Periodical home visiting by public health or social service nurses for the frankly or dangerously ill; occupational therapy in the home under direction of social service organization or Voluntary Aid Society. (c) Periodical examination at the clinic for those capable of attending with directions regarding rest and exercise, or work. (d) Reports of public health or social service nurses regarding home conditions of patient with respect to preventive measures, those features important for his or her recovery, and as well, with respect to contacts and the apparent degree of exposure. (e) The institution of subnormal workshops or sheltered employment with periodical examination at the clinic.
II. Suspect cases—only possibly tuberculous, certain cases tentatively regarded as incipient.	(a Report of public health or social service nurses regarding home conditions. (b) Clinical observation and periodical examination until the diagnosis of clinical tuberculosis is made or excluded. (c) Admission to observation beds of the clinic or possibly to a Sanatorium as ''suspect''
III. Previously tuberculous—	(a) Periodical examination at the clinic in accordance with the circumstances of each case.
IV. Contact cases—	(a) Periodical examination at the clinic; a single examination resulting in negative findings should not be regarded as sufficient.

available, or a limited number of hours spent preferably at their previous type of work unless this is distinctly unfavorable in character.

(c) Full-time occupation while carrying out the restrictions advisable or feasible according to the circumstances of the individual and his or her employment.

For some of those in Class ''a'' and all in ''b'' and ''c,'' revisional examination at the clinic should be made periodically, the purpose of which is to prevent by advice any relapse. As this is

impossible to foretell, the patient should be encouraged to seek re-examination and advice, whenever he is feeling under his par or suspicious that he is not making favorable progress, or even holding his own.

Class II. With the suspect cases the clinical observation should be continued until the diagnosis of tuberculosis can be excluded or confirmed. For many such cases observation beds are almost essential, or failing these, for the protection of the case, admittance to a sanatorium advised. This, however, is a serious step to take chiefly on account of the attitude of the public (including employers) and insurance companies towards ex-sanatorium individuals. The desired diagnosis in perhaps the majority of this class can be achieved while the individual continues at his employment.

Class III. The classification of previously tuberculous should properly include only those in whom the diagnosis of a positive tuberculous lesion was made by chance, such as might occur when an x-ray examination was made for other purposes. Their histories may or may not reveal evidences of symptoms which in the past were appreciated by the patient and which might be regarded as due to their positive tuberculous disease. This classification is in a way superfluous as it comprises individuals in whom the contingency of re-exacerbation is perhaps less likely than in those one may subclassify under Class I as "arrested" or "apparently cured." It was added with the object of emphasizing our profession of faith; namely, that freedom from clinical tuberculosis is based upon previous infection whether or not this results in a demonstrable lesion—preferably not. In such "previously tuberculous" cases it is advisable to give a reassuring explanation and to make revisional examinations even though at comparatively long periods of time.

Class IV. It is chiefly from our contact cases—whether the contact be known or not—that clinical tuberculosis is evolved. Among those for whom we know the exposure has been intimate and perhaps excessive, the most careful type of examination and clinical observation should be carried out, and repeated until it is reasonable to conclude that there is little or no danger of the advent of tuberculous disease. This is particularly applicable to childhood contact with adult tuberculosis.

Under the heading of disposal and supervision in the chart on after-care, and in the different paragraphs of this section, an attempt

has been made to show the need of cooperation between the medical personnel of the clinic, of the sanatorium, and the various official or voluntary agencies for welfare work which will vary in different communities. It is impossible in many cases for the clinic physician to give the best advice unless he has some knowledge of the patient's home surroundings. It is equally impossible to expect a public health nurse to render the valuable services which she can, and which will nearly always be appreciated by the patient and his family unless she has been provided with a report outlining the medical diagnosis and the type of restricted life he should be leading.

The practical value to the physician which is afforded by the report of the public health nurse upon the patient's housing conditions, type of life (work and habits), character of family and inmates, etc., cannot be overestimated; the sooner this is filed the better. As a rule the first report should be confined to such headings as the above; the character of subsequent reports will depend to a great extent upon the individual case (refer to Table C). Nurses who have previously had a few months' training in a sanatorium will be able to give much more valuable aid than those who are without this.

Unless some simple system is devised whereby the follow-up service is brought immediately into touch with the physician's diagnosis, mistakes will occur in the instructions and suggestions to the patient by the visiting nurse, which will tend to mar the public's acceptance of public health measures. If the head nurse of the clinic is used as the connecting link between the physician and the visiting nurses it will for instance prevent the latter from issuing anti-tuberculosis instructions to a case which has a few days previously been assured by the physician that the disease is not tuberculous. Such are not infrequent misunderstandings in the average public health tuberculosis clinics, and are due to lack of time on the part of the physician, the absence of clerical assistance and consequently lack of coordination of the work within the clinic.

The two fundamental aims in the supervision of the tuberculous are, first, the prevention of the spread of the disease by insisting that the patient and his house contacts observe the comparatively simple, but necessary precautions; and second, the creation of the most favorable circumstances for the arrest of the disease so that

as far as possible each case will achieve as complete a recovery with as extensive a work capacity as is possible. The first aim is more essentially a matter of public health, while the second is not only humanitarian but in a very considerable degree a question of national economy.*

A public health nursing service is perhaps the only organization which can hope to forward both aims, but every opportunity should be taken to urge those philanthropically inclined to participate in certain features of the second aim. The preventoria for children which are so valuable an asset for childhood tuberculosis clinics provide a striking example of effective philanthropic work done in Canada by the I.O.D.E. These institutions for the clinically free, tuberculin positive, children fulfil a purpose which lies midway between a sanatorium and sheltered employment for adults.

If there is a children's hospital in the municipality the tuberculosis clinic for those of that age-group will probably fulfil its purpose to greater advantage if it is held there. If there is no such hospital, it should form a part of the adult clinic; under any circumstances the closest contact should be maintained between the two, both as regards medical personnel and administration. This is important because the medical "précis" of the adult tuberculous should be available when the children contacts are being examined, and because a certain number of the children who have been kept under observation and treatment, will in the course of time be transferred to the supervision of the adult clinic. Such correlation is valuable both for our own more thorough understanding of the disease and for the better protection of the case, when, for instance, the now young adult begins remunerative employment.

If there is a laboratory division attached to the adult clinic, it should serve in the same capacity to the children's clinic, not only because of the increased opportunity for fundamental work afforded to the laboratory, but because of the practical benefit to both clinics and their medical personnel.

The relative value of different clinical methods in adult and childhood tuberculosis takes on different proportions such as the contrast afforded by the use of the x-ray and the use of tuberculin

*It is worthy of note that at the recent provincial election in Saskatchewan, the Government in appealing to the electorate made public health measures with special reference to antituberculosis clinics one of the features of their platform; they were elected with a strong majority.

but the same type of organization and administration is needed for both. The value of preventoria has been mentioned; to this should be added the open air schools, whether these are conducted in the preventorium or in connection with the regular public school system. Even comparatively limited experience with childhood tuberculosis will convince one that children separated out for open air teaching by the public school inspection should pass through the clinic.

Sheltered employment for the tuberculous, more or less permanently disabled, must be regarded as in the experimental stage. It is impossible to go into the various contentions which have been raised in the discussion of this question; but were some such type of suitable employment available, it would not only simplify the disposal of many cases, but would at the same time lessen the possibility of relapse. It seems a short sighted policy to make every effort to effect a timely diagnosis, to spend[1] what we do on sanatoria, and then to discharge the quiescent or arrested case back to competitive employment under which in the majority of instances he is likely to relapse and within five or more years be dead or practically a total disability. "It is probably not an exaggeration to say that any scheme which does not include the whole life of the consumptive must end in failure."[2] The provision of suitable working conditions for, and supervision therein of the case brought to arrest by the timely diagnosis on the part of the clinic together with appropriate residence in a sanatorium, is just as important a part of the work of the clinic as is the creation of satisfactory diagnostic facilities. Expressed economically the case without suitable work and supervision relapses and becomes a total disability and a charge directly or indirectly on the state. With suitable work and proper supervision there are good prospects of eventually effecting full working capacity in a large percentage of the cases, and in the others a prolonged if not a continuous period of part-time work.

Thus organized and conducted, "the clinic" is placed logically as

[1]Tuberculosis and The Sanatoria Statistical Bulletin Metropolitan Life Insurance Company, 1, 7, July, 1920.

[2]The Care and Employment of the Tuberculous Ex-Service Man after Discharge from the Sanatorium. Board of Tuberculosis Sanatorium Consultants, to the D. M. S. Department of Soldiers' Civil Re-establishment, Ottawa, report No. 6 (W. M. Hart) 1920. This report deals with the different aspects of past sanatorium care in the most exhaustive and instructive fashion.

the center of the fight against tuberculosis, in the scheme of which sanatoria may be said to act usually as temporary resting places for those in whom a timely diagnosis has rendered an arrest or apparent cure a probable outcome, or as homes till death for certain of the dangerously ill, most of whom probably are in their condition because of a diagnosis too long deferred. Cooperating with the clinic are the municipal public health departments with their public health nursing staffs, and as well, different voluntary organizations which are or may be induced to participate in the fight.

This type of work cannot be carried on without the clerical assistance which is needed, (1) to gather together the results of the various parts of the investigation of the individual case as soon as these are completed, and (2) to keep up to date whatever system has been adopted to ensure that the directions resulting from the clinician's initial and revisional examinations are carried out at the time intended, whether these affect the patient directly or indirectly through the nursing or welfare services. It is operating against the purpose of the clinic if repeated reattendance of the patient, who perhaps should be in bed, is the chief means used to remind the clinician that the case has not been disposed of because, on his previous appearance, some feature of the examination was lacking. It is further false economy if the physician or the nurse is required to do what nonprofessional clerical assistance could accomplish as well or better.

This means the expenditure of money. Salaries must be paid to nurses and clerical assistants; neither can public health departments expect the amount of time needed to be donated gratuitously by the physician. The professional training and requirements for the work is a high grade of "specialism" which unlike the surgeon's ability does not command high fees in private practice. Consequently the physician, except in rare instances, cannot afford to give the necessary time, and if he can, is unlikely to bring to bear either the necessary training or experience.

In planning a tuberculosis clinic there remains for consideration the number of nurses in proportion to the population and the basis on which to calculate the number of physicians required. Winslow,[3] in discussing the former, states that for adequate service

[3]The Tuberculosis Problem in Rhode Island: C-E. A. Winslow and W. E. Chandler, 1920, Snow and Farnham, Co.

there should be one nurse for every fifteen hundred to two thousand of the population. Undoubtedly this ratio will vary in accordance with the extent of the development of public health methods and information available in different areas of the country; to a slighter extent the means of transportation and the density of the population served will affect this ratio. For cases confined to bed and not capable of attending the clinic the number of visits should average from eight to twelve a year. On the other hand, for those cases capable of performing more or less full-time remunerative work, living a more or less restricted type of life and reporting periodically to the clinic and possibly as well under the advice of their family physician, the visits are not likely to average more than four a year. In the interests of public health an initial visit is advisable for all classes from "suspect" up to frank tuberculosis.

The rate at which patients can be examined by the physician will depend to a great extent upon the facilities he has to assist him in the diagnosis, the convenience of these adjuncts, the extent of clerical assistance, and the simplicity of the systems adopted to keep the records or clinical histories "alive." In a report to the National Tuberculosis Association on Tuberculosis Dispensary Methods[4] a unit basis of four to five patients per hour per physician is recommended, estimating this on the maximum attendance. This ratio is based upon the standard set by the Association of Tuberculosis Clinics of New York, which requires as a minimum allowance, eighteen minutes for each new patient, nine for each old patient reexamined, and three minutes for interviewing each old patient not examined. I would personally prefer to add from two to seven minutes to the time set for the initial examination so that in particular more time would be available for the elicitation of details of the history. Three minutes is a very short period of time in which to gain the confidence of the patient and obtain the data upon which the patient and the social service should be directed. Allowing for time spent in noting the correlated data supplied by different divisions of the clinic, a standard of two to three patients, old and new, per hour would produce much more thorough and conclusive work. To offset this lessened ratio, the frequency of attendance with a corresponding lengthening of the interval could be

[4]Tuberculosis Dispensary Method and Procedure: F. Elizabeth Crowell Pamphlet 107, Vail-Ballon Co., New York, 1916.

advised, with I believe beneficial results. Except for teaching purposes there is no reason why all the data which are obtainable and pertinent at the time should not be collected in practically all instances at the time of the first or at the most a second closely spaced attendance. This second attendance should serve to complete the investigation initiated as a logical continuance of the first examination, and need occupy little or none of the physician's time. If eight to ten patients are fully examined initially or revisionally in one full day, the physician will have little time or spirit to do more.

With careful organization within the clinic the number of attendances for continuance of the investigation following the clinical examination, as well as attendances for treatment such as with tuberculin, vaccines or possibly proteins, can be very materially increased without jeopardizing the effectiveness of the work. If, however, there are more cases for complete clinical examination than can be done thoroughly, the quality of the results and consequent advice or direction must suffer.

The question of charts or history forms is important, but is one which many circumstances will tend to modify. Except possibly for teaching purposes the fewer the printed headings under which the clinical history, from the remote or recent onset, is taken the better. "Fortnightly summaries" requiring positive or negative answers to a long series of symptoms and clinical findings are in my opinion useless for practical purposes. The history form should provide sufficient space for one to take a good history, and allow data, elicited later but belonging to this part of the examination to be recorded there. A rubber stamp for recording the date, temperature, pulse, respiration and weight is a convenient way of distinguishing the different revisional examinations, and comparing at a glance these four clinical features together with any other observations on symptoms, work capacity, etc. Rubber stamps for any important feature which may be dealt with as a temporary or permanent routine are effective and cheaper than excessively printed forms.

The diagram of the thorax should be sufficiently large and simple to allow one to record clearly those physical signs thought desirable; a rubber stamp for this is never satisfactory. If the files are to be kept "alive" for re-examination, some supplementary system of card indexing will be necessary.

The scope and organization as outlined in this chapter is, I believe, more extensive than that usually assigned to or accomplished by a tuberculosis clinic. The economic, apart from the humanitarian, aspect is sufficiently grievous to justify any moderate expenditure, if thereby there seem to be reasonable prospects of eradicating or materially reducing the extent of disability due to tuberculosis and its yearly mortality.

MENTAL HYGIENE CENTERS

By C. K. Clarke, M.D., LL.D.

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Among the important advances made in preventive medicine during the last decade are those in connection with mental hygiene, and the splendid accomplishments of the National Committees for Mental Hygiene in the United States and Canada are object lessons well worthy of a careful study. Ordinarily, the subject of mental abnormality has been regarded as outside of the province of public health departments, even in large cities, and mental disease has been relegated to the police officials to deal with as a species of crime that should be suppressed. In such a center as Toronto a broader conception of the question has been developed, and a beginning made in the study of the complex problems arising from the presence of mentally handicapped children in schools and the reasons why these members of the community are undeveloped or diseased.

It is true that in some centers in the United States, public health authorities hold aloof and allow school administrators to deal with the subject of mental abnormality simply from the lay standpoint, employing psychologists to make the diagnosis and suggest the treatment. This system must be empirical as the problem is largely a medical one and can only be dealt with satisfactorily by well qualified psychiatrists. Psychologists have their place and usefulness, but are not in a position to make the final decision in the majority of instances.

It is well known that a proportion of problem cases in public

schools are suffering from definite forms of mental disease, such as dementia precox, manic depressive insanity, psychopathic conditions, syphilitic lesions, etc. There is a tendency by the lay observer to feel that in making psychological tests for example, that Jack is as good as his master, and that when an intelligence quotient has been obtained a teacher is in a position to deal with his pupil satisfactorily. Such is not the case, and mental tests, while essential and useful when properly interpreted, are only a link in the chain of evidence required to make a proper diagnosis. It is more important to suggest the line of action to be followed if the pupils are to be developed properly and the public protected from those who early in life exhibit antisocial tendencies.

Necessary as it is to supervise the physical weaklings in schools and to weed them out in the interest of themselves and others, it is even more important to make a proper survey of the mentally defective and diseased. It is, of course, difficult to get school communities to understand this, and oftentimes boards of education are apt to class any attempt made to control the situation as another frill and fad. Facts, however, speak for themselves and when the tragedies enacted daily in juvenile courts and police courts are carefully analyzed, it is readily perceived that a public health department may easily become the most important factor in any community in preventing crime and vice of many kinds.

Fortunately it is no longer necessary to draw on the imagination or foreign sources for facts and figures to establish the contention that public health officials have it within their power to guard mental health just as carefully as physical health.

An analysis of some of the figures issued by the Psychiatric Department of the Toronto General Hospital is worth while. Some 5600 cases have passed through the clinic during the last few years. These came from the Public Health Department, Juvenile Court, and various social organizations of the city. No less than 51 per cent of these were of school age and the majority of the delinquents were to be found in the school age columns. Take, for example, the girls following prostitution. These furnished 29.5 per cent of the females examined, and practically all belonged to the defective class, the morons predominating.

If these girls had been discovered during the period of their school life and guarded by an efficient public health system, the tragedy

of their lives might have been prevented. As these girls are the chief distributors of venereal disease and ordinarily go astray during school age, it is readily understood that outside of the sentimental and humanitarian side of the question, there is another important aspect to be considered. If the suppression of venereal diseases is a great public health question, surely it is desirable to discover and cut out the known sources of infection at the earliest moment possible. The figures published by the Toronto General Hospital Clinic are verified by the statement of psychiatric observers everywhere,—in other words, prostitution is one of the most important subjects to be dealt with and studied by the mental specialist. Prevention, then, is of greater importance than legislation and treatment.

Again, when it is learned that something over fifty per cent of the patients taken to the clinic were of school age, it is at once apparent that the welfare of the community demands a careful scrutiny of those who have in the majority of instances transgressed the statutes. It is more and more apparent that law cannot longer ignore the study of the individual in its desire to punish the crime rather than undertake a scientific study of the perpetrator, before passing sentence.

More and more is medical sentiment demanding a proper mental study of the delinquent. Already a psychiatrist is recognized as a necessary member of a juvenile court staff, and it is an open question as to whether or not any case of juvenile delinquency should be pronounced upon before a thorough mental study of the offender has been made. Of course such a plan does not always meet the approval of the general public, but after all the public is not a safe guide where mental abnormality is suspected.

The study of certain conditions of labor in connection with mental health is suggested as a profitable field for investigation. From the Toronto Clinic figures it is only too apparent that some types of mental weaklings flock to factories where simple work and low wages go hand in hand. The amateur social service worker frequently insists that low wages are the reason why so many of these factories are hives of immorality. A survey of the factory girls seen in the clinic makes it only too evident that public health departments may prove of inestimable value in protecting these girls whose defective brains are the cause of their mental and moral failure.

To show how serious this problem is, it may be said of 117 females recently admitted to the clinic no less than fifty-two were factory workers—all mental defectives,—and of 2425 females examined a very large percentage came from the same class. Among these, too, are occupational wanderers, that is, mental weaklings who drift about from one factory to another, always inefficient and restless as well as dissatisfied. Such facts as these open up a big field for study and treatment by well organized public health departments.

The question of illegitimacy cannot be overlooked, as the unmarried mother is so frequently mentally defective or insane. The clinic figures show that the unmarried mothers made up no less than 13 per cent of females examined, and of these 80 per cent were either mentally defective or insane, and of course their progeny are likely to continue the story of defect and degeneracy. To show how our social organizations fail in handling this problem it is interesting to know that in eighty-eight cases the patients were mothers of two illegitimate children, in nineteen of three, and in two of four. Surely preventive medicine has not been active in these.

So much empty sentiment exists in the community that it is difficult to handle these cases without exciting the resentment of amateur social reformers who deal in theory and choose to ignore facts and experience. Unfortunately great numbers of foreign born continue to swell the ranks of the unfortunate, and it is only since the establishment of the Federal Department of Health that an attempt has been made to supervise the immigrants as to their mental capacity.

The clinic has demonstrated this in a most startling manner. It has found that over three per cent of the female admissions were made up of defective girls brought to the country by societies promoting juvenile immigration. Practically all of these became unmarried mothers, many were persistently immoral, and others had venereal disease. In other words, we had deliberately added to our troubles without thought of the future.

Fortunately the Federal Department of Health has acted promptly and is steadily improving the methods of inspection. In spite of any form of inspection that may be devised, a certain proportion of high grade morons and mentally diseased persons will get into the country. Public health officials may be of the greatest assistance in discovering the weaklings and arranging for their

deportation—indeed it is a duty that cannot easily be performed outside of mental health centers.

The importance of mental health centers having been established, the following organization is suggested as advisable in dealing with the different problems referred to.

(1) In cities of 40,000 or more, the appointment of a psychiatrist and social service department, under the control of the public health department, to make mental surveys of all delinquents of school age and to make frequent examination of mentally handicapped children in the public schools.

(2) The establishment of central clinics for the extended study of defective individuals and the building up of special classes for the development of these children.

(3) A careful study, by specially trained social workers, of home conditions, family history, environment, etc.

(4) The opening up of psychiatric clinics in psychopathic hospitals where they exist. These clinics should have the most intimate identification with public health departments; in fact they should be as closely allied as venereal clinics are at the present time.

(5) The placing of children charged with offences in proper homes for care and observation until they are taken to a central clinic for study and investigation.

(6) The study from a mental standpoint of workers in factories where cheap labor is employed, with the idea of helping to improve a situation that has in the past been a contributing cause to vice and immorality.

(7) The supplying of venereal clinics with psychiatrists and mental nurses.

(8) The establishment of traveling clinics for rural centers, where the services of psychiatrists are not available. The use of such clinics has long ago been demonstrated and they would work in conjunction with school authorities and local magistrates.

THE DIAGNOSIS AND TREATMENT OF VENEREAL DISEASES UNDER PUBLIC HEALTH DIRECTION

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Venereal diseases at the present time, in Canada, are the only diseases for which a federal government grant is made for the purpose of supplying free treatment. Until recent years treatment of venereal diseases by medical men was often unsatisfactory because (1) the patient would not remain under observation long enough; (2) he frequently resorted to quack treatment; (3) medical men often were not willing to take the time to treat the cases as they should be treated and would occasionally refuse to treat such cases at all; (4) the patient did not have enough money to carry on his treatment faithfully as directed, and often thought lengthy treatment unnecessary.

In some countries, England, for example, rich and poor are treated alike and all may receive free treatment under government supervision. In some parts of the United States free treatment is provided only for those unable to pay, and there are a few "pay clinics" for those who could not pay for a physician's treatment but who could pay something towards the price of the drugs, etc. In most of these "pay clinics" the charge is purely nominal. In Canada there are as yet no pay clinics, and free treatment is provided only for those unable to pay. All others are expected to receive their treatment from their own private physicians.

In these countries means for the diagnosis of venereal diseases are provided free of charge, or, if not free, at a purely nominal price for all patients. There are government laboratories in practically all the states in the United States and in the various provinces in Canada where Wassermann tests are done, dark-field examinations for spirochetes, and examinations of smears for gonorrhea, etc., made, all free of charge. In addition free arsenical preparations are provided by the government when the patients themselves are unable to pay for these.

In a government scheme for the treatment of venereal diseases in any country the following points are essential:

1. Laboratories for free diagnosis at strategical points.
2. Free venereal disease clinics for patients unable to pay in cities of 15,000 to 20,000 and over. (These should have adequate facilities for social service follow-up work).
3. A comprehensive scheme for the treatment of poor patients in the smaller cities, towns, rural municipalities and unorganized areas.
4. Adequate arrangements for the examination and treatment (if necessary) of inmates of Government institutions such as jails, reformatories, penitentiaries, asylums, etc.
5. Hospital accommodation for acutely infectious cases and any other venereal disease cases requiring hospital care.
6. Whole-hearted cooperation and approval of the practicing physicians.

(1) Laboratories

The laboratories should be either established and maintained by the government, or under government control or supervision. These should be equipped so as to be able to make blood examinations, examine smears, etc., as well as for other public health laboratory work. Special laboratories are not required but existing ones should be utilized by enlarging their scope to include all the established venereal disease examinations. Special attention to the Wassermann test is essential. Gonorrheal fixation tests might be carried out if considered advisable. The main laboratory might manufacture arsenical preparations for distribution, free of charge, to poor patients, or to physicians at cost. If this is not deemed necessary, arrangements should be made with reliable commercial firms to buy arsenical preparations (or other drugs) at low rates for the treatment of poor patients.

(2) Treatment of Free Cases in Cities

The treatment of free cases in cities of 15,000 or over is a comparatively easy task. Special venereal disease clinics should be established and assisted by government grants. Careful inspection will be necessary to insure efficient treatment of all those applying for it. Other things being equal, hospital out-patient departments

should be utilized for these clinics. Hospital clinics are to be preferred to the so-called "down town clinics" or public health clinics occasionally used, for the following reasons:

(a) It is easier to maintain secrecy since a patient may be visiting a hospital for a variety of reasons.

(b) Specialists such as internists, dermatologists, neurologists, etc., are readily available for consultation.

(c) There is educational value for the hospital authorities in connection with the treatment of venereal diseases. This makes the admission to hospital of venereal cases a relatively simple task.

(d) The expense of maintaining a clinic is greatly diminished.

(e) The public, including medical students and nurses, are educated to the idea that venereal diseases are being treated in the same manner as other diseases.

(f) As a rule patients prefer to go to a general hospital for treatment rather than to a clinic set aside entirely for the treatment of venereal disease.

(g) Most hospitals now have some form of social service department and this can be easily enlarged to include the necessary follow-up of venereal cases.

It is, of course, recognized that in special circumstances and under certain conditions, a down town clinic may be better for the city concerned; and it is also recognized that there are many excellent clinics situated down town in office buildings, etc., where patients are being efficiently treated; but the consensus of opinion seems to be that the hospital out-patient department is the better place for the establishment of the venereal disease clinics.

Some of the essential points in connection with public health venereal clinics are:

1. Syphilis and gonorrhea should be treated in these clinics but if possible at different hours.

2. Men and women should have separate hours for attending the clinic and should be kept separate at all times in the waiting rooms and treatment rooms. This is an extremely important point and should be absolutely insisted upon.

3. Night clinics for the treatment of gonorrhea and syphilis and for the treatment of men and women are necessary.

4. If possible, the clinic should be open at all hours, and a skilled

File No. .... ONTARIO Service............

Provincial Board of Health

Referred by.........

SOCIAL HISTORY

VENEREAL DISEASE CLINIC

Serial No........................ At.........................

Name.........................Date.....................O. P. D.........

Address	Sex..... Date of Birth....S. M. W. D.
....	Time in Canada ....
....	Time in Present Locality ....
....	Religion ....
....	Church ....

Nationality.................Birthplace ....Mentality ....

Occupation .... Industry ....

Wage................................ Hours of Work ....

Recreation ....

....

Relatives ....

Address...

Agencies Interested ....

Home Conditions ....

Family	Age	V. D.	Other Particulars...........
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

Means of Identification ....

Weight ....Height........... Hair........... Eyes ....

Complexion..........Peculiarities of Appearance, Gait or Speech..........

Sexual History ....

(1) First Illicit Intercourse ....

(2) Reasons for Such ....

(3) If Continued, Why? ....

....

(Over)

Fig. 125.

attendant always on duty to give information and early treatment if required.

Clinic rooms should be large, clean, cheerful, bright, well-lighted and well ventilated. Some advise posters in the waiting rooms, and insist that literature on venereal disease should be available. If posters are used, they should be cheerful and instructive, pointing out the necessity of continued treatment, but should not stress the ravages of the diseases.

Source of Infection

Name ....**Address** ....
Occupation ....**Nationality** ....**Age** ....**S. M. W. D.**
Means of Identification ....
Weight ....**Height** ....**Hair** ....**Eyes** ....
Complexion........**Peculiarities of Appearance, Gait or Speech**............
Mentality ....
Town of Exposure ....
Dates of Exposure (1)..........**(2)**............**(3)**...........**(4)**.........
Where and When Did Parties Meet, Circumstances, etc. ....
....
Length and Nature of Social Intercourse ....
Was There Solicitation? ....
Was Money or Other Consideration Accepted? ....
....
....
....

Circumstances Under Which Infection Took Place.
(1) Park, Where ....
(2) Automobile ....
(3) Hotel ....
(4) House of Prostitution ....
(5) Home ....
(6) Other, (Specify) ....

Does He or She Know of Any Others Infected by the Same Person (Particulars) ....
....
....
....
....
....
....
....
....
....
....
....

(Over)

Fig. 126.

There should be separate but connecting rooms for social service, appointment office, clinical examination, treatment rooms (one for male G. C., one for female G. C., and one for syphilis cases), small laboratory and small resting room for patients who have received arsenical treatment, etc.

ONTARIO

Provincial Board of Health

SOCIAL HISTORY PROGRESS SHEET

VENEREAL DISEASE CLINIC

AT

....

SERIAL NO. .... **NAME** ....

DATE	

(Same on opposite side.)

Fig. 127.

The great difficulty in many hospitals at the present time is to get the necessary space. Special provision has not been made in hospitals for adequate out-patient accommodation so that there is a tendency to treat such cases in basements and in poorly ventilated and poorly lighted rooms. All this, of course, renders the development of large clinics more difficult and, as well, tends to lower the morale of the patients.

Personnel.—The personnel should include:

1. An administrative medical officer in charge of the clinic. He should be a specialist, have a sound knowledge of general medicine, as well as have administrative ability, and be able to inspire confidence in his patients.

2. Other specialists for treating syphilis and gonorrhea in men, women and children.

3. Still other specialists, internists, radiologists, neurologists, ophthalmologists, etc., should be available for consultation if deemed necessary.

4. Social workers—the number depending on the size of the clinic. Social workers should be graduate nurses if possible, though many lay social workers are doing excellent work. Male social workers are used in addition in some clinics, but they are not a necessity.

5. Adequate nursing assistance in the clinic;—this includes both nurses and male attendants.

6. Adequate clerical assistance for keeping reports of social and medical histories, examinations, and records of various kinds. The clerical help will include a filing clerk who will be responsible for the maintenance of an adequate system of records.

Apparatus and Furnishings.—This should include the necessary equipment for the treatment of any case of gonorrhea or syphilis. Many lists of this kind have been worked out and may readily be obtained through departments of health. To do efficient work, urethroscopes, cystoscopes and dark-field apparatus should form part of the equipment.

The furnishings should be simple, plain but substantial. A few pictures, etc., will brighten up a waiting room wonderfully and will well repay the expenditure, in the improved morale of the patients.

Records.—Full medical and social case records should be kept. It is often advisable to keep the medical and social records separate to insure privacy. This may or may not be done depending on the local conditions. It is important to interest the physician in the social case record as this information is often of value in the treatment of the case. The social service nurse should only visit those cases whom the physician feels the visit will benefit.

As the clinic grows, the physician will come to appreciate the importance of these visits, and more of them will then be requested.

The social case history is a rather recent innovation. One that may be found of value in a venereal clinic is shown here (Figs. 125, 126, 127). This is in use in several clinics in the Province of Ontario and has been giving satisfaction as well as being of service in furnishing information and statistics in connection with the social and moral problems involved in the cases treated.

Duties and Qualifications of the Social Service Nurse.—The employment of a social service nurse in the treatment of venereal diseases is a recent development. She has, however, a very important duty to perform and it is not too much to say that on her more than any one else, depends the success or failure of the clinic. A tactless nurse may do even more harm than a tactless physician. Her qualifications should be tact, sympathy, common sense, cheerful personality, knowledge of her duty, general nursing knowledge, and general public health knowledge. Her most important qualifications are tact, sympathy and common sense.

The duties of this nurse may be considered under three heads:

1. **In the Clinic.**
   (a) Education of the patients concerning venereal disease during the clinic hours.
   (b) To assist in case taking, especially of the female patients, and case-filing.
   (c) To make waiting rooms attractive and patients comfortable while waiting and following treatment.
2. **Outside Clinic.**
   (a) Follow-up work if patients discontinue treatment.
   (b) Finding people who have not been cured.
   (c) Should be able to take specimens and smears from women and children.
   (d) Search out individuals who have venereal disease and report them to the Medical Officer of Health.
   (e) Tactful education to prevent spread among contacts.
   (f) Assist in obtaining treatment for infected pregnant mothers.
   (g) Cooperate with other specializing nurses in her district.
3. **Work with Social Agencies.**
   (a) Help to bring together social agencies and law enforcement authorities.

(b) Help in the restoration and rehabilitation of the unfortunate.
(c) Interest agencies in seeing that all cases receive treatment.
(d) Interest commercial and industrial institutions in the venereal disease problem.
(e) Assist in improving recreational opportunities.
(f) Do general community educational work along venereal disease lines at every opportunity.

(3) **Treatment in Small Centers**

In smaller centers it is often much more difficult to provide treatment as clinics are not feasible on account of the publicity and the the high cost of upkeep. There are at least four ways of dealing with the problem:

1. The government may supply apparatus and drugs for the treatment of the cases and also supply a specialist for consultation when desired, leaving the remainder of the expense in connection with the treatment of the case to be borne by the municipality. If the municipality is unorganized, it may be necessary for the government to pay the physician directly for the treatment given.

2. The government may advance money to the individual to pay his or her railway fare or other means of transportation to the nearest clinic. The municipality in such cases may pay the clinic for the treatment given.

3. Physicians may be paid directly by the government for treatment given indigent patients if this is necessary to obviate undesired publicity in connection with the treatment. In such cases the local medical officer of health might decide who the indigent patients were and who should give the treatment.

4. Traveling clinics may be established, operated and maintained by the government.

Any one of these schemes might be satisfactory depending on the country concerned. The main desire should be to see that no patient is prevented from receiving adequate and efficient treatment through inability to pay for such treatment.

(4) **Treatment in Institutions**

The government should, of course, see to it that all persons in custody are examined for venereal disease and that they receive

adequate treatment while so detained. This is necessary both in the interests of the patients themselves and the other inmates who might otherwise be exposed to infection. It is especially important that physical examinations, Wassermanns, smears in the case of women, and in men if there are any signs of gonorrhea, should be a routine procedure in all institutions. This should apply equally to all penal institutions, reformatories, etc., as well as institutions for the insane. When the infected inmates leave the institutions, they should be compelled to continue their treatment either with private physicians or in public clinics. There is a field for social service work in connection with the contacts of infected individuals in government institutions especially in connection with institutions for the insane.

(5) **Hospital Treatment**

Hospitals should be encouraged and, if necessary, compelled to take in, as patients, acutely infectious cases who are a menace to the public if left at large. If considered advisable a small grant for the treatment of such cases may be paid by the government to hospitals. A great change along the foregoing lines has taken place in the last few years and hospitals are more and more recognizing that their duty to the public demands the admission and treatment of venereal cases the same as cases of typhoid fever and pneumonia.

(6) **Cooperation**

Finally to obtain the best results the government scheme must have the whole-hearted cooperation of all physicians. Physicians are now beginning to realize their public health duties and are acting as their own social service nurses and instituting the necessary action through their own efforts or referring the cases to the local medical officer of health. No clinic in North America wishes to treat patients who are able to pay a physician for their own treatment and there is no doubt that free clinics will in the long run help the medical profession by treating cases who were previously treated only through the generosity of the medical profession.

SCHOOL HEALTH SERVICE

By J. T. Phair, M.B., D.P.H.

Chief Medical Officer, Department of Education of Ontario (Toronto)

The establishment of school health service or school health supervision is the result of an appreciation by pioneers in the field of preventive medicine of the latent possibilities of the school as a center for the dissemination of information as to the value of good health. It had its inception in a small way in France in 1833, and later about 1840 permissive legislation was introduced into Sweden with the object of making it nation-wide. It was not, however, until 1874 in Brussels, that a well-defined plan for a large center was adopted. The movement spread to North America about 1894. Boston was the first city on this continent to adopt medical inspection of its school children. The importance of the work being now generally appreciated, it has come to be an accepted part of school activities in practically all of the larger and many of the smaller centers of population everywhere.

The primary object of this service was to assist in preventing the spread of communicable diseases, and it has been an important factor in the progress that has been made in that direction. However, the attention of those especially interested in this field of child welfare and disease prevention generally, having been focused on the physical defects found in children of school age (defects which might have been prevented or cured in early childhood) it was felt that school medical inspection if extended to include this field, could be made a valuable weapon in any campaign for better health.

The extension of what had formerly been called school medical inspection to include a complete physical examination of school children, involved changes in the type of workers in this field, and the school nurse was introduced. Previous to this the work had been done by physicians only. They inspected daily the children referred to them, excluded those with any evidence, or suspicious sign of communicable diseases, and that was practically all. Now, however, what had previously been an inspection became an examination, the completeness of which was limited only by the apparent

condition of the child and the degree of cooperation of the parent. The results of these examinations were reported to the parents and treatment, when necessary, was used. It was early seen that something more than mere notification of defects found, was necessary, if much was to be accomplished in the way of correction. It was in this follow-up work, so-called, that the nurse became invaluable. By her tactful and accurate presentation of the condition and its possible ill effects, she brought home to many parents the need for correction of not only the defect itself, but the conditions which were responsible for its existence. While it is impossible in this article to discuss at length the need for this type of service, its urgency may be emphasized.

With reference to communicable diseases, advantage should be taken of every opportunity that presents, to prevent the spread of the acute infectious conditions. By means of a system of school health service which includes a routine examination, as thorough as possible, and corroboration of the findings, when suspicious, by home visitation of all children who have been absent from school on account of illness, much could be accomplished. Early exclusion of suspects and contacts should also be carried out. Teachers and parents should have some knowledge of the prodromal symptoms of these diseases in order that they may recognize them if they develop. Also they should have an appreciation of the time when these diseases are most communicable.

In the Province of Ontario, in 1920 with a school population of 500,000, there were 33,704 cases of acute infectious diseases reported, not including mumps, chickenpox, tuberculosis or infantile paralysis, with over 1,100 deaths. It is apparent, therefore, that the need is great.

The conditions which are classed as remediable physical defects are even more prevalent. The results of surveys conducted by conservative examiners are as follows: 15 per cent of children examined have defective vision, 20 per cent have defective nasal breathing, and 30 per cent abnormal or diseased tonsils which warrant treatment. There are in addition many children with adenitis or enlargement of the thyroid, orthopedic defects, chest or heart lesions, and a great number of ill-nourished anemic-looking children who are the victims of malnutrition. To these must be added the

great number found to be suffering from dental defects. Combined they constitute a group large enough to demand our best efforts. With such facts in mind, the advantages to be gained by the establishment of some practical form of supervision for the rural and small urban communities is being emphasized by all organizations interested in educational and health work.

In recommending the introduction of this type of service in any community, opposition is occasionally raised on the ground of the expense involved. The fallacy of this assumption can be easily proved, and the reverse shown to be the case when it is realized that an enormous amount of money is wasted annually in the provision of educational facilities for children who are absent from school through illness. While no actual figures are available, a conservative estimate would show that there is more than four times as much money spent in this way in every community, rural or urban each year, than it would take to establish an efficient form of school health supervision, and, as this service when well established should without difficulty eliminate more than one quarter of the time lost through illness, the matter becomes one of economy rather than of expense. For example, if there are 100 children of school age in any community, the annual budget must be based on the expectation that all of these children will attend every day. Now if the average attendance is 75 per cent (and this is about the actual proportion) and it costs $50.00 per year to educate each child, then $1,250 is wasted each year, and if 15 of these 25 children are absent directly from illness, then $750 is the amount actually lost in this way. If this community were linked up with neighboring school sections to form a unit of say 30 class-rooms supporting a system of school health supervision, its share of the cost would amount to about $150 and there should result a saving to the community, and an increase in health and happiness.

The amount expended by any state or municipality for the care of individuals, the victims of lack of early health supervision, is more than sufficient to finance an adequate scheme of prevention. Institutions for the care of incurable children, for the blind, the mental subnormal, the deaf, and for epileptics, all house many who are suffering directly or indirectly as the result of uncorrected defects in early childhood.

In initiating this work in any community, rural or urban, there

are two concrete things to be kept in mind—first, the object in view; second, the simplest way of accomplishing it.

An elaborate organization which would include a staff of oculists, chest specialists, pediatricians, dentists and nurses would be ideal, but naturally is difficult to obtain. In this connection it must be kept in mind that the object is not to have the state or municipality assume the responsibility of the parent, but merely to assist him in carrying it, by directing his attention to the need of the subnormal child, for treatment.

There are three methods of carrying out this work of health supervision. The first, by the employment of local physicians who are engaged on a part-time basis, to examine the children periodically and report their findings to the parents. As this type of service makes no real provision for the control of communicable diseases, or the necessary follow-up work of school nurses, it is the least desirable form of school health service.

However, by the employment of men and women who feel that in this way they may render service to those who otherwise would be deprived of it, and if all suggestions of treatment are avoided, much may be accomplished. No arrangement, however, whereby the children are examined at so much per head, so many times a year, is worthy of the name of health supervision. When individual examinations are made, each child should be examined as thoroughly as time and the cooperation of the parents will permit. The consent of the parents to the removal of sufficient clothing to make the examination of real value should always be requested. An examination of the children two or three times during their school career, and making such suggestions in regard to the school buildings and surroundings as are likely to improve the environmental conditions are about all that the physician doing this type of work, can accomplish.

The second plan is one in which a full-time school nurse is employed, who, by means of regular inspection and a physical examination, attempts to have treatment established when necessary. The inspection of the physical appearance of the child and observation of its actions, together with the previous history, and an examination of any defects should, if properly made, be worth while. The nurse's knowledge of the significance of the prodromal symptoms of the communicable diseases, the importance of segregation and

the methods of carrying it out, render here a valuable auxiliary in this field.

In establishing this form of school health supervision in a larger center, a number of well-trained nurses, under a capable supervisor can be welded into a reasonably efficient organization for the conduct of this type of work (in no case should one nurse have supervision over more than 2,000 children). Criticism of this plan, on the ground of absence of medical supervision, has been offered by many. If it is remembered, however, that practically all the conditions which may be thus discovered, present fairly characteristic symptoms, this criticism seems hardly warranted. For example, in the case of diseased tonsils; while it may be assumed that no nurse, however well trained, can with any degree of certainty say that a child has diseased tonsils, it must be remembered that this is not necessary. All that is essential is to direct the child, who is evidently below par, *into the accepted channels for treatment.* Now if a child of this type, with enlarged, congested or deeply pitted tonsils, enlarged pre-cervical glands, a history of persistent absence from school, and repeated attacks of sore throat, or cold, appears for examination, surely a nurse would be justified in referring such a child to the family physician, saying that the child was apparently suffering from abnormal tonsils.

The same is true of defective vision, hearing, breathing or malnutrition, anemic appearance or dental defect. The all important thing which the school nurse must remember is, that her training may qualify her to say with a fair degree of certainty that a child is sufficiently below par, physically, to warrant reference to the family physician; but it does not, however, permit her to say definitely at any time, that any child is suffering from a specific condition, or what the treatment for that condition is. When the school nurse bears this in mind, she becomes a most valuable part of any system of school health supervision.

The third form of supervision, which includes all the recognized agents—medical officer, dental officer, and nurse—is undoubtedly the most desirable when efficiently manned, and sufficient scope given for expansion. When these desiderata are met, satisfactory results are promptly obtained.

It has, however, two disadvantages. The first is the cost. If it is to be thoroughly efficient the medical and dental service should

be a full-time one, and rendered by well trained men and women, who appreciate fully what may be accomplished. However, in some places very excellent work is done by part-time physicians, under the supervision of a full-time director. The second disadvantage is, that too much emphasis is sometimes placed on the treatment aspect of the work.

Under such a system the complete physical examination of children should be made as thorough as possible, the physician giving the major portion of his time to this work. Endeavor should be made to have as large a percentage as possible of parents present at the examination in order to emphasize the significance of the defects found, and the possibilities if these are not corrected. A minimum as well as a maximum length of time should be allotted to each examination, and if the parent is present and nothing of moment is discovered as the result of the examination, an effort should be made to impress the parent with the value of regular, thorough health supervision of all children. It is very essential that the parent go away from the examination room impressed with the importance and real value of the service rendered.

As the major proportion of the physician's time is taken up with the complete physical examinations, the nurse, of necessity, must make readmissions and exclusions of cases of suspected communicable diseases. Those so excluded must then be visited by the physician on the same day, and when the diagnosis is made, they should be referred to the health department for future supervision.

The school medical officer should avoid offering any suggestion to the parents as to the type of treatment necessary. The phase of the work should be left entirely in the hands of the family or clinic physician.

The follow-up work of the nurse, or home visitation, is of inestimable value in obtaining corrections, not only in the case of the child whose parent has not been able to attend the examination, but also in the case of parents who have postponed the visit to the physician or clinic as suggested by the school medical officer. The nurse investigates the unexplained absence of children from school and is of material assistance in checking up unrecognized or unreported cases of communicable diseases.

The educational aspect of the work is very important, and the possibilities are almost unlimited. The school medical officer and nurse

aid the teacher in her efforts to make the teaching of hygiene a matter of interest and profit, by daily demonstrating the practical value of the simple rules of good health.

The supervision of physical education and a readjustment of the curriculum to suit the physical capabilities of the children is a phase of the work sometimes overlooked by school physicians. Greater appreciation of the value of ventilation, heating, seating, cleanliness and sanitation in the school generally, are urged on all those connected with this type of service. It is suggested that a form should be provided on which would be recorded the temperature at various points and levels in the schoolroom, the presence or absence of sufficient movement in the air and its humidity; the water, its source and mode of distribution; the presence of facilities for washing; the cleanliness of school buildings; the method of heating and sanitary conditions generally. This form should be filled out accurately at regular intervals, the physician and nurse taking advantage of the opportunity thus presented to teach a lesson on the value of proper sanitation.

School dental inspection is a very valuable adjunct to any system of school health supervision. Its value lies chiefly in the fact that current ideas of parents as to the need of treatment for deciduous teeth are very vague, and a definite statement to them as to which teeth need attention and the type of treatment needed, carries considerably more weight, than a general statement on the part of the nurse or physician that dental treatment is necessary. There is great need for a much clearer grasp of what oral hygiene really means, and what neglect of its principles involves. Educational effort to accomplish this can best be done by a school dental officer.

The question of the establishment of dental treatment centers is one worthy of a great deal of attention, involving, as it does, the expenditure of a considerable amount of money. It is a movement that might be construed to be an acceptance, by the municipality or state, of the parent's responsibility. Under present economic conditions, however, it is felt in many places that free dental treatment is an absolute necessity.

The usual mode of procedure is to have the dentist make an annual or semiannual survey of all the children, notifying the parents which teeth are affected and the need for treatment. Short talks are given to the children explaining the purpose of the pri-

PROMOTION RECORD—INSTRUCTIONS TO TEACHER

THIS CARD MUST FOLLOW THE PUPIL FROM ROOM TO ROOM AND FROM SCHOOL TO SCHOOL
a, b, c, d, e MUST ALWAYS BE KEPT UP-TO-DATE. f AND h AND i MUST BE ENTERED WHEN THE PUPIL LEAVES A ROOM OR GRADE (BY PROMOTION TRANSFER ETC.) AND AT THE END OF THE SCHOOL YEAR

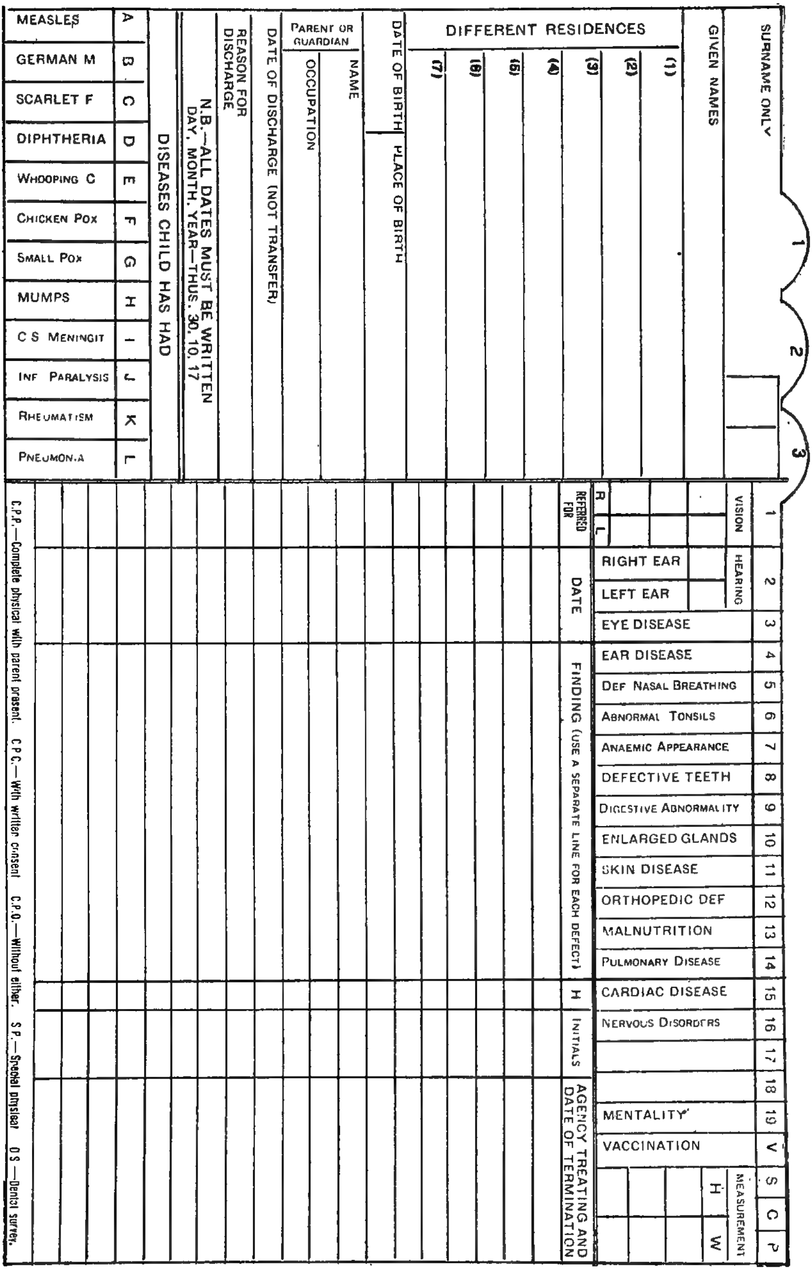
a SCHOOL	b DATE OF ADMISSION	c AGE SEPT 1 YRS	MOS.	d GRADE	e ROOM NO	f DAYS PRESENT	h CON-DUCT	i SCHOLAR SHIP

IN COLUMNS h AND i, A—EXCELLENT B—GOOD C-FAIR D—POOR.

CONSULTATIONS AND HOME VISITS

PUPIL'S INDIVIDUAL CONTINUOUS RECORD CARD NO 1
SCHOOL SYSTEM AND DEPARTMENT OF PUBLIC HEALTH—TORONTO LOWE-MARTIN CO

Fig. 128.—Appendix—school health service. (Obverse.)



SURNAME ONLY

GIVEN NAMES

DIFFERENT RESIDENCES

(1) (2) (3) (4) (5) (6) (7)

DATE OF BIRTH | PLACE OF BIRTH

PARENT OR GUARDIAN: NAME | OCCUPATION

DATE OF DISCHARGE (NOT TRANSFER)

REASON FOR DISCHARGE

N.B.—ALL DATES MUST BE WRITTEN DAY, MONTH, YEAR—THUS, 30.10.17

DISEASES CHILD HAS HAD

MEASLES	A
GERMAN M	B
SCARLET F	C
DIPHTHERIA	D
WHOOPING C	E
CHICKEN POX	F
SMALL POX	G
MUMPS	H
C S MENINGIT	I
INF PARALYSIS	J
RHEUMATISM	K
PNEUMONIA	L

1	VISION R L
2	HEARING RIGHT EAR / LEFT EAR
3	EYE DISEASE
4	EAR DISEASE
5	DEF NASAL BREATHING
6	ABNORMAL TONSILS
7	ANAEMIC APPEARANCE
8	DEFECTIVE TEETH
9	DIGESTIVE ABNORMALITY
10	ENLARGED GLANDS
11	SKIN DISEASE
12	ORTHOPEDIC DEF
13	MALNUTRITION
14	PULMONARY DISEASE
15	CARDIAC DISEASE
16	NERVOUS DISORDERS
17	
18	
19	MENTALITY
V	VACCINATION
S C P	MEASUREMENT H W

REFERRED FOR | DATE | FINDING (USE A SEPARATE LINE FOR EACH DEFECT) | H | INITIALS | AGENCY TREATING AND DATE OF TERMINATION

C.P.P.—Complete physical with parent present. C.P.C.—With written consent. C.P.O.—Without either. S.P.—Special physical. D.S.—Dental survey.

1 2 3

Fig. 129.—Appendix—school health service. (Reverse.)

mary teeth, their mode of eruption, the time of arrival of the permanent set, their care, and the value of a well balanced diet in the prevention of dental decay.

When treatment centers are thought necessary, they are established at various points. The children who are to receive treatment are selected by the school nurse, and the consent of the parent to administration of such treatment as the dentist deems necessary is obtained in writing. If extraction is contemplated, that fact is stated on the "consent card." This is very necessary, especially when this work is first inaugurated in any community.

The question of records is one that a great deal of thought and time has been expended upon. It is exceedingly difficult to get a physical record card which includes all the essentials and is reasonably convenient. Such a record should contain all the information that bears on the physical make-up of the child. The results of both superficial and complete examination, the academic standing, the home and school environment, how the pupil reacts to these and any other factors which may have influenced his present condition, should be indicated. This card will also have to be large enough to serve the child throughout his whole school career. The pupil's individual continuous record card, as used in Toronto, and recommended by the Provincial Department of Education of Ontario for use throughout the province, combines most of the necessary features.

The forms used to notify parents, of conditions found, and whether treatment or merely observation is deemed necessary, are made in duplicate, one is given to the child, the other is filed by the nurse in the medical inspection room.

Exclusion forms for noncommunicable conditions, uncleanliness, etc., are also in duplicate while those used for exclusion of contagious diseases are in triplicate, one going to the parent, one to the health department, and the third is filed at the school. Consent cards and appointments for parents to attend complete physical examination of children can be sent home by the child, mailed, or delivered by the nurse as may be desired. These when signed, are returned to the school by the child, or brought by the parent at the hour appointed for examination.

Records are invaluable and must be kept, and they should be sufficiently accurate to permit their use as a record of the physical con-

dition of any child applying for employment, at the end of the school career. But it must also be borne in mind that the clerical side of the work must not be permitted to hamper the original purpose of the movement, by taking up too much time of physician, dentist, or nurse.

In conclusion I would like to emphasize the value of this work when well done, and make a plea for a better grasp of the aims of the work, namely, that it is not merely an attempt to have existing physical defects corrected, but it is prompted by a desire to eliminate the underlying conditions which are responsible for their existence, and in so doing aid in the establishment of a better appreciation of the value of good health in every community.

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